
Coding Games
in SCRATCH™
A STEP-BY-STEP VISUAL GUIDE TO BUILDING YOUR OWN COMPUTER GAMES

Coding Games

in SCRATCH™

Coding Games in Scratch™

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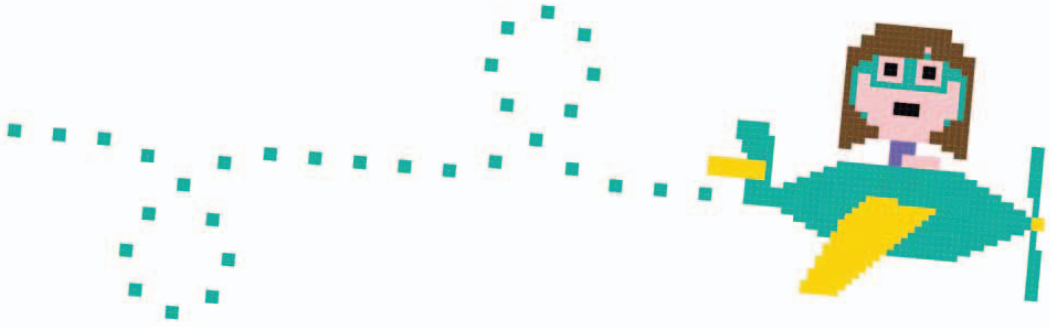

DR. JON WOODCOCK MA (OXON) has a degree in physics from the University of Oxford and a PhD in computational astrophysics from the University of London. He started coding at the age of eight and has programmed all kinds of computers, from single-chip microcontrollers to world-class supercomputers. His many projects include giant space simulations, research in high-tech companies, and intelligent robots made from junk. Jon has a passion for science and technology education, giving talks on space and running computer programming clubs in schools. He has worked on numerous science and technology books as a contributor and consultant, including DK's *Computer Coding for Kids* and *Computer Coding Made Easy*.

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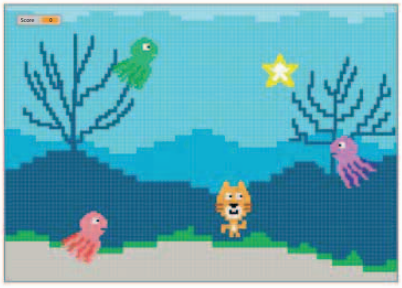

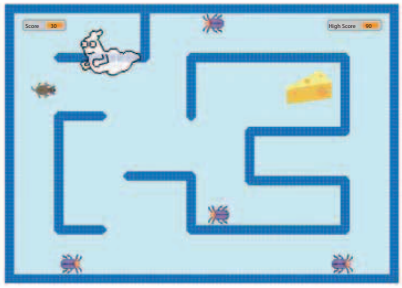

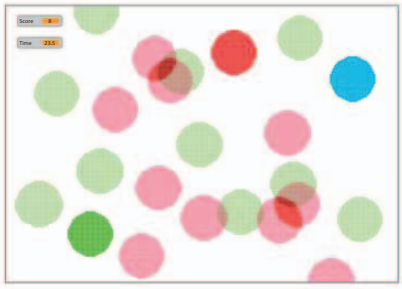

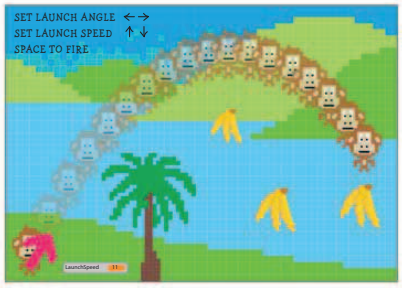

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Foreword

Many of the people who have shaped our digital world started out by coding games for fun. Bill Gates, cofounder of Microsoft, wrote his first computer program at the age of 13—a tic tac toe game. Just a few years later a teenage Steve Jobs and his friend Steve Wozniak, who later founded Apple together, created the arcade game Breakout.

They started coding simply because they enjoyed it. They had no idea how far it would take them or that the companies they were to build would change the world. You might be the next one like them. Coding doesn't have to become a career, but it's an amazing skill and can unlock exciting doors to your future. Or you might just want to play around with code for the fun of it.

Computer games open up worlds of imagination. They reach out across the internet and allow us to play together. They are packed with creativity, from music, stories, and art to ingenious coding. And we're hooked on them: so much so that the games industry is now worth more than the movie industry. It's huge.

And now, instead of being just a player, you can become a game maker too. You can take control of every aspect of those imaginary worlds: how they look, sound, and feel. You get to invent the stories, the heroes, the villains, and the landscapes.

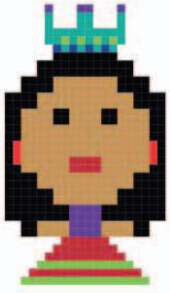
But first you need to take control of your computer. To tell a computer what to do, you need to speak its language and become a programmer! Thanks to languages like Scratch, it's never been easier. Just follow the simple steps in this book to build each game and you'll see what goes on inside each one. Follow the chapters in order, and you'll pick up the essential skills you need to design and build your very own games.

1

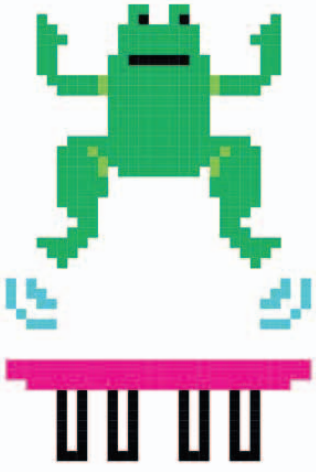
Computer games

What makes a good game?

Some games have a magical quality that makes you want to play them time and again. Game designers call it playability. To make a game with great playability, you need to think about all the ingredients that make up the game and how they work together.



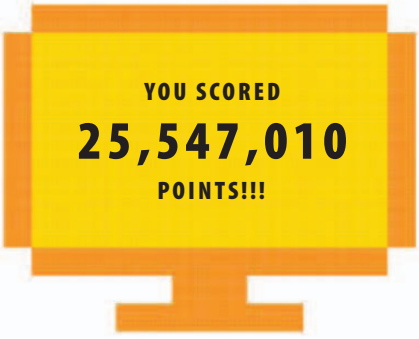
◁ **Characters**
In most games, the player uses an on-screen character to enter the game world. It could an animal, a princess, a racecar, or even just a simple bubble. To create a sense of danger or competition, such games usually also have enemy characters that the player has to defeat or escape from.



△ **Mechanics**
These are the "verbs" in a game—actions such as running, jumping, flying, capturing objects, casting spells, and using weapons. The mechanics are the core of the game, and well-designed mechanics make a good game.

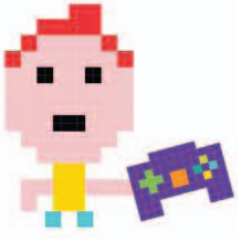
△ **Objects**
Nearly all games include objects, from stars and coins that boost health or scores to keys that unlock doors. Not all objects are good—some get in the player's way, sap their health, or steal their treasures. Objects can also work together to create puzzles for the player to solve.

◁ **Rules**
The rules of a game tell you what you're allowed and not allowed to do. For example, can you walk through walls or do they block your path? Can you stop and think or do you have to beat the clock?



△ **Goals**

Every game challenges the player to achieve some kind of goal, whether it's winning a race, conquering an enemy, beating a high score, or simply surviving for as long you can. Most games have lots of small goals, such as unlocking doors to new levels or winning new vehicles or skills.

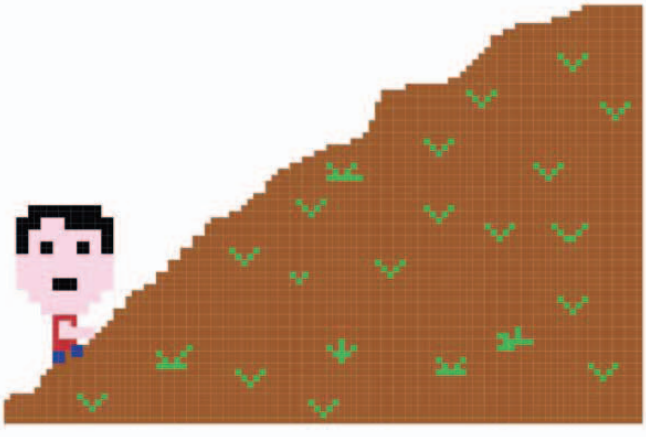


◁ **Controls**

Keyboards, mice, joysticks, and motion sensors all make good controllers. Games are more fun when the player feels in complete control of the character, so the controls should be easy to master and the computer should respond instantly.

◁ **World**

Think about the world in which a game is played. Is it 2D or 3D? Does the player view the game from above, from the side, or from within? Does the game world have walls or boundaries that limit the player's movement or is it open like the outdoors?



△ **Difficulty level**

A game's no fun if it's too easy or too hard. Many games make the challenges easy at the start, while the player is learning, and more difficult later as the player's skills improve. Getting the difficulty level just right is the key to making a great game.

GAME DESIGN

Playability

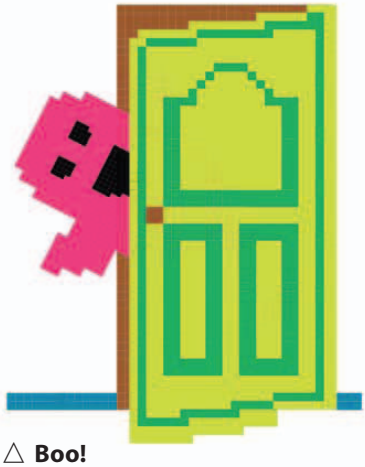
Games don't have to be complicated to make people want to play them over and over again. One of the first successful computer games was a simple tennis simulator called Pong. The ball was a white square and the racquets were white lines that could only move up and down. Although there were no fancy graphics, people loved Pong because it had great playability. They could compete against friends, just like in real tennis, and it was just hard enough to demand intense concentration and a steady hand, leaving players always wanting another game.

Atmosphere

A good game, just like a movie or a book, can draw you in and change the way you feel by creating a certain atmosphere. Here are some of the tricks game designers use to conjure up an atmosphere.

◁ **Telling stories**

A background story helps set the scene for a game and gives meaning to the player's actions. Blockbuster games have movielike plots with twists, but even simple games can benefit from some kind of story if it makes players feel they're on a mission. Thinking of a story also helps you give a game a consistent theme.

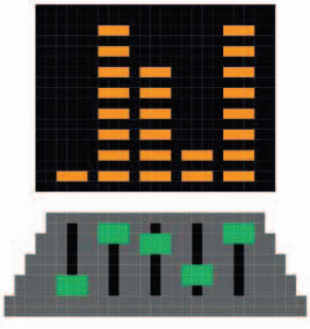


△ **Boo!**

Do things jump out at the player? Fear and suspense can make a game scary and put the player on edge. What's around the next corner? What's behind that door? The wait can be worse than the scare!

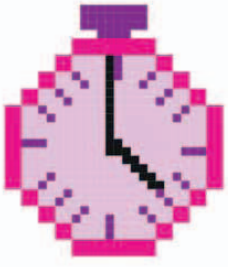
▷ **Sound**

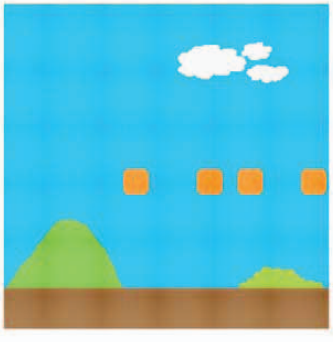
Sounds can have a strong effect on how we feel. Changing the tune can make the same scene feel exciting, scary, or even silly, and a sudden noise after a quiet spell can cause a jolt of terror. Modern games use realistic sound effects to make players feel like they're inside the action.

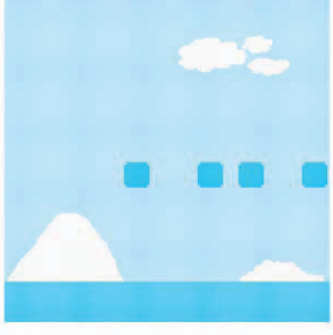


▷ **Faster, faster!**

The speed of a game changes the level of excitement a player feels. It's easy to stay calm when you can stop and think about what to do next, but with a ticking clock and fast music, you can't help but feel under pressure.



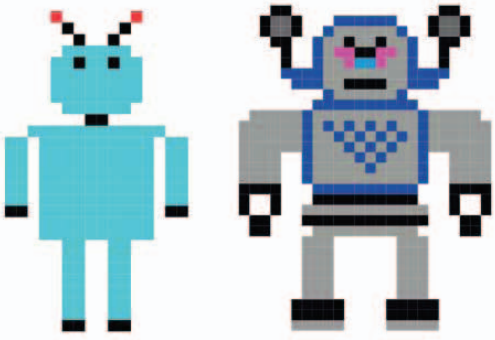




◁ **Color scheme**

You can change the atmosphere in a game simply by altering the colors. Bright blue, yellow, and green feels warm and sunny, for instance, while icy blues and white feel wintry, and darker colors make a game feel spooky.

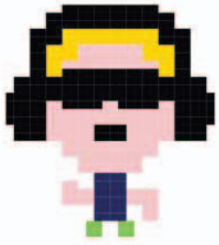
▽ **Graphics**
The graphics in the first games were simple geometric shapes, but as computers became more powerful, the graphics in games got better. Many console games now feature photorealistic 3D images, but games based on simple, cartoonlike graphics are as popular as ever and can help create a more playful atmosphere.



GAME DESIGN

Virtual reality

Virtual reality goggles could make the games of the future much more realistic. They work by presenting each eye with a slightly different image, creating a 3D experience. Motion sensors in the headset track the player's movements and adjust the images to match, allowing the player to turn around and look in any direction, just like in the real world. As a result, a player feels inside the game world rather than watching it through a screen.



Where are you?

One of the easiest ways to create atmosphere is to give a game a location by adding a background image. To make the illusion more convincing, make sure the game's characters match the setting—don't put racecars in the deep sea or unicorns in outer space, for instance.

◁ **Snow and ice**
A snowy scene is the backdrop for a race along an icy road.

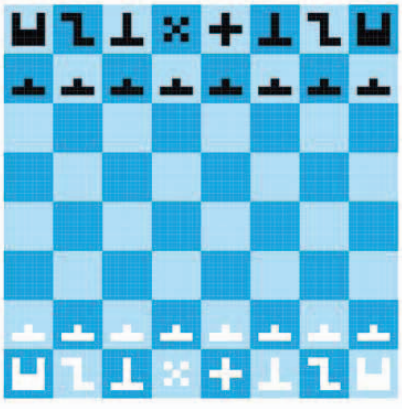
△ **Spooky forest**
A dark forest is the perfect setting for ghosts, ghouls, and witches.

△ **Tropical beach**
A sunny beach creates a carnival mood for the colorful steel drums.

△ **Deep-sea adventure**
Octopuses and starfish fit well with this underwater scene.

Types of games

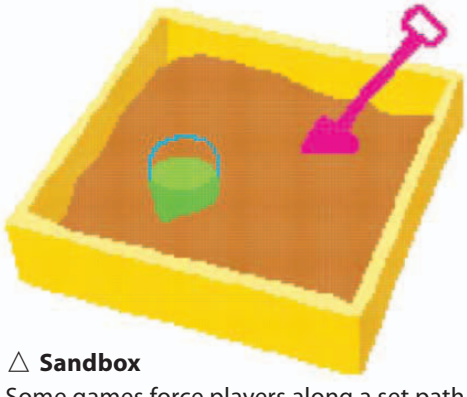
Games come in all shapes and sizes, but most fit into one of just a few main categories, called genres. Some gamers like the platform games genre best, whereas others prefer racing games or strategy games. What are your favorite genres?



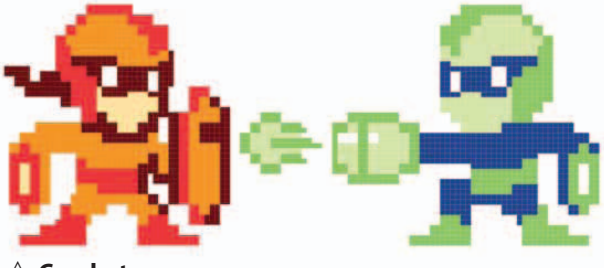
◁ **Traditional**
When you can't find an opponent to play with you, a computer can challenge you to a game of cards, chess, or a million other popular board games.

△ **Role-playing**
Dungeons, dragons, and castles feature in these adventure games. Players may roam freely or follow a set storyline, with their character developing specialized skills as it advances, such as casting spells or sword-fighting. Some role-playing games are played online, allowing lots of players to interact in the same game world.

▷ **Racing**
Racing games create the illusion of speed by making the scenery scroll past the player's viewpoint. To succeed, you need to learn each racetrack inside out so you can start tricky maneuvers in advance.



△ **Sandbox**
Some games force players along a set path, but sandbox games are the opposite: they give you complete freedom to explore the game world at your own pace and choose different quests within it.



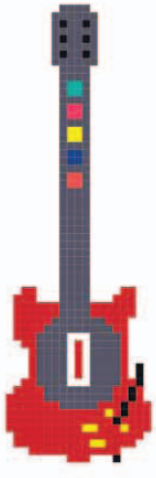
△ **Combat**
Nimble fingerwork is vital for games involving close-quarters combat. The key to success is knowing when and how to use many different attack and defense moves, from slams and somersaults to special powers.

▷ **Strategy**

Decisions, decisions. What are the best choices to make if you're running a zoo, fighting a war, or building a whole civilization? Strategy games give the player godlike powers over many different characters at once, but you have to manage resources cleverly or your empire will collapse.

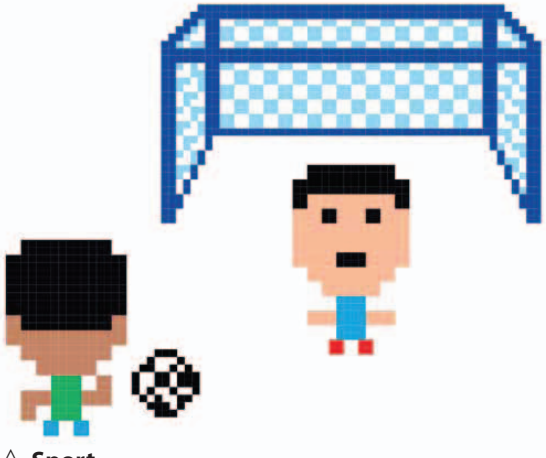
△ **Simulator**

If you want a puppy but don't want the trouble of feeding and walking it, a virtual pet might suit you. Simulators aim to re-create real-life situations. Some are more than just a game: flight simulators are so accurate and realistic that professional pilots use them for training.



◁ **Music and dance**

Dance-mat games involve tapping the feet or jumping over a stream of obstacles in time to the rhythm. Music games allow you to play along with a virtual band using a pretend instrument. You need to hit the right notes on time to complete each level.



△ **Sport**

Play the game of your choice as your favorite team, set in a realistic stadium with roaring crowds. Sports games let you compete in famous tournaments such as the soccer World Cup, with the computer referee ensuring fair play.

△ **Puzzle**

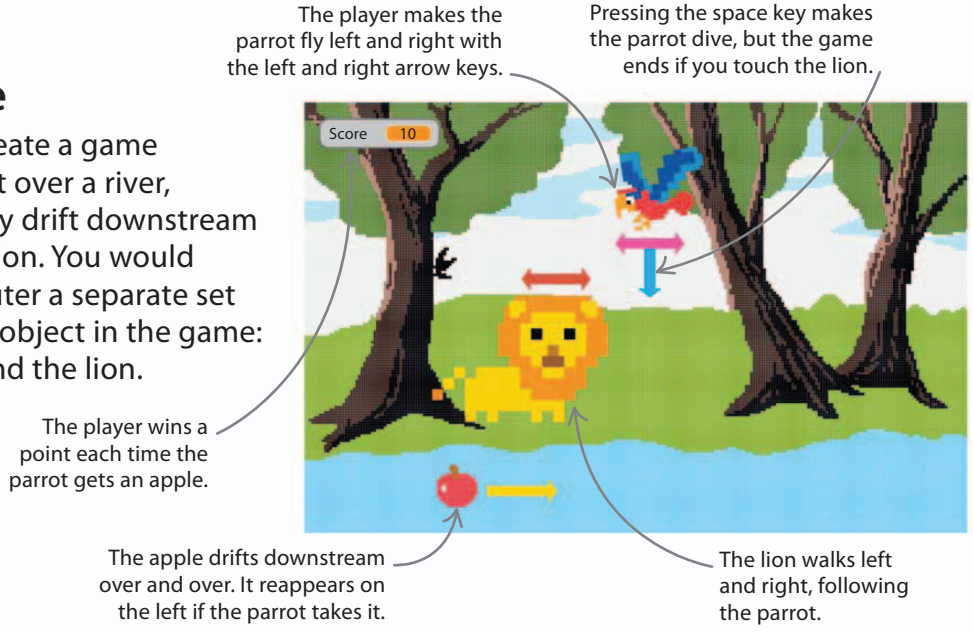
Some people love to exercise their brains with puzzles. There are many different types, from colorful tile-matching games to number puzzles and escape games, in which you need to use your imagination to find your way from room to room.

How coding works

A computer can't think for itself—it works by blindly following instructions. It can only carry out a complex task if that task has been broken down into simple steps that tell it exactly what to do and in what order. Writing these instructions in a language a computer understands is called coding.

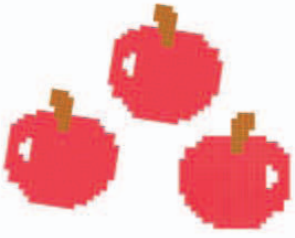
Planning a game

Imagine you want to create a game in which you fly a parrot over a river, collecting apples as they drift downstream but avoiding an angry lion. You would need to give the computer a separate set of instructions for each object in the game: the apple, the parrot, and the lion.



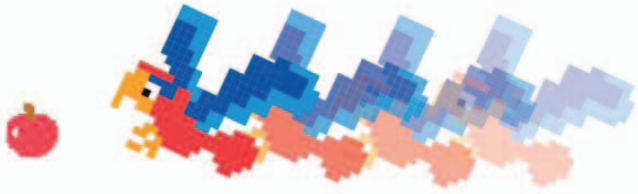
▽ **Apple**

You can't simply tell the computer that the apple drifts down the river and vanishes when the parrot eats it. Instead, you need to break down this complicated task into a set of very simple steps as shown here.



```
Jump to the left edge of the screen.
Repeat the following steps over and over again:
    Move a bit to the right.
    If I get to the right edge of the screen then
        jump back to the left edge.
    If I touch the parrot then
        add one to the parrot's score and
        jump back to the left edge.
```

▷ **Parrot**
The parrot is more complicated than the apple because the player controls it and it can move up, down, left, and right. Even so, it's possible to make all of this work by writing a sequence of simple instructions.



```
Jump to the top right of the screen.
Repeat these steps in turn:
    If the player presses the left arrow then
        move a bit to the left if I can.
    If the player presses the right arrow then
        move a bit to the right if I can.
    If the player presses the space key then
        move all the way to the bottom of the screen taking a second and
        move all the way back to the top taking a second
```

▷ **Lion**
The lion is the player's enemy and can end the game if the parrot touches it. It is controlled by a simple program.

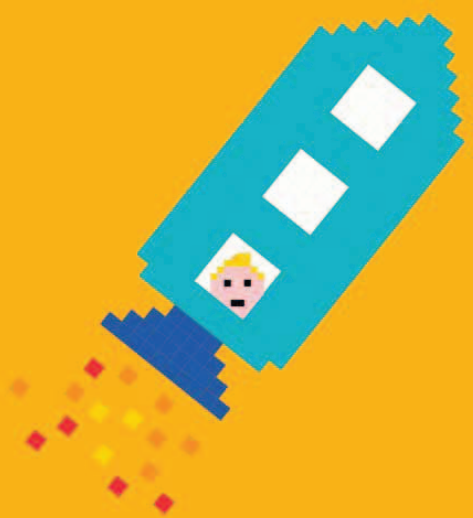
```
Jump to the middle of the screen.
Repeat these steps in turn:
    If the parrot is to my left then
        move a bit to my left.
    If the parrot is to my right then
        move a bit to my right.
    If the parrot touches me then
        stop the game.
```

LINGO

Programming languages

The instructions on this page are in simple English, but if you wanted to create the game on a computer, you would need to translate them into special words that the computer can understand: a programming language. Writing programs with a programming language is called coding or programming. This book uses the programming language Scratch, which is ideal for learning about coding and great for making games.

Getting started



Introducing Scratch

All the games in this book are made with a programming language called Scratch. Scratch is easy to learn because you don't have to type any complicated code. Instead, you build programs from ready-made blocks.

Starting from scratch

A project in Scratch usually starts with choosing the objects, or sprites, that will appear in the game. Scratch has a large library of sprites, or you can create your own.

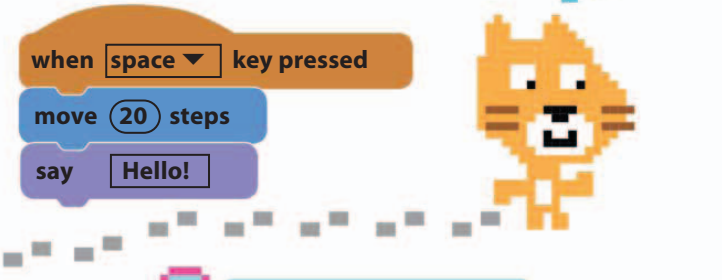
Sprites

Sprites are the things that move around or react in the game. They can be anything from animals and people to pizzas or spaceships. You can bring each sprite to life on screen with a list of instructions called a script.

The cat sprite appears whenever you start a new Scratch project.

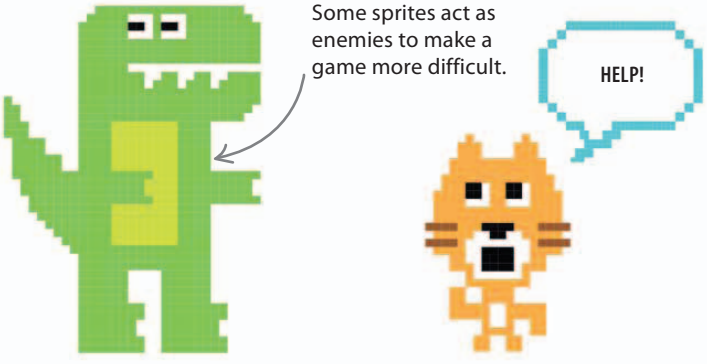
Scripts

Scripts are made of text blocks that you can drag with a computer mouse and join like pieces of a jigsaw puzzle. Each block has one instruction so it's easy to understand.



Working together

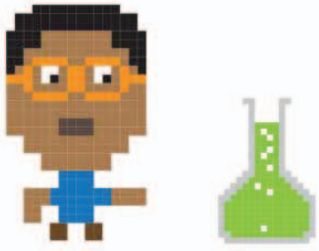
Games are usually made up of several sprites working together, each controlled by its own script. Scripts make sprites move around, crash into each other, create sounds, and change color or shape.



EXPERT TIPS

Experimenting

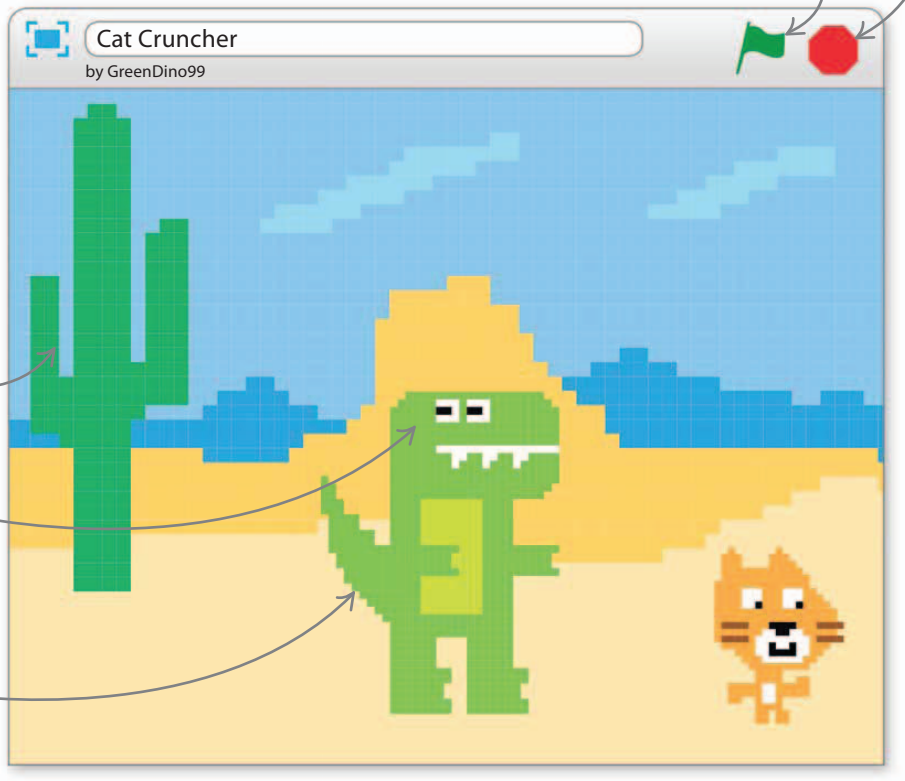
Scratch is all about experimenting. Once you've built a game, it's easy to add things to it or change how it works by tinkering with the script. You can see the effect of your changes straight away.



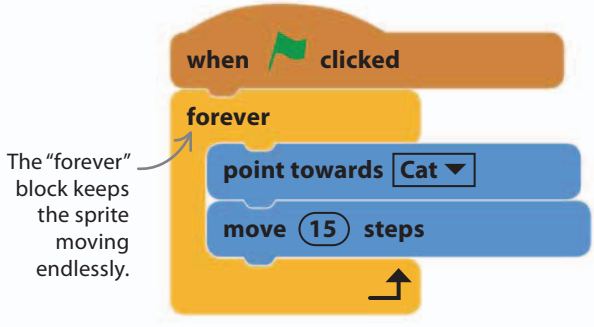
A typical Scratch project

Once you've built a script, you can click the green flag to see what it does. All the action takes place in a part of the Scratch window called the "stage". Sprites move about on the stage, often in front of a background image that helps create atmosphere.

▷ **Running a program**
Starting, or "running", a program activates the scripts that you've built. To make the stage fill your whole computer screen, click the blue symbol in the top left.



▽ **Making sprites move**
In a typical game, the player moves one sprite and the other sprites are programmed to move automatically. The script below makes the dinosaur in this project chase the cat.



Getting Scratch

In order to try the projects in this book, you'll need to set up Scratch on a desktop or laptop computer. The two ways of setting up Scratch (online and offline) are shown below.

LINGO

Why "Scratch"?

Scratch is named after "scratching", a technique rappers and DJs use to remix music on a turntable. The Scratch programming language lets you copy other people's projects and remix them to make your own unique versions.

Online Scratch

If you have a reliable internet connection, you can run Scratch online in a browser window without downloading anything. You will need to set up a Scratch account.

1 Join Scratch

To set up the online version, visit the Scratch website at **scratch.mit.edu** and click "Join Scratch". You will need to set up an account with a username and password. Your games will stay private unless you click "Share", which will publish them on the web.

2 Sign in

After you've joined the Scratch website, click "Sign in" and enter your username and password. It's best not to use your real name as your username. Click "Create" at the top of the screen to start a new project. If you use the online version of Scratch, you can access your projects from any computer.

Offline Scratch

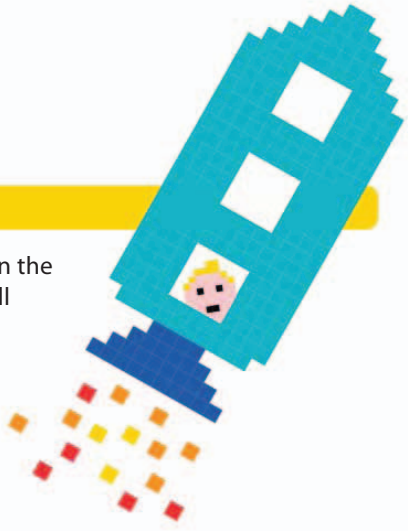
You can also download the Scratch program to your computer so you can use it offline. This is particularly useful if your internet connection is unreliable.

1 Install Scratch

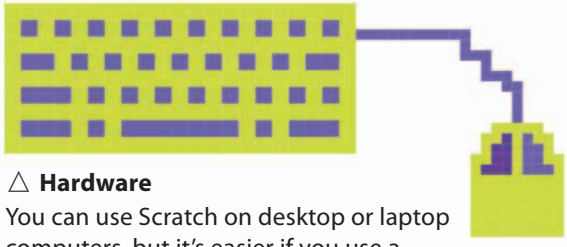
For the offline version of Scratch, go to **scratch.mit.edu/scratch2download**. Follow the instructions on screen to download the installation files, then double-click them. After installation, a Scratch icon will appear on your desktop.

2 Launch Scratch

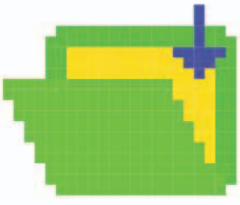
Double-click the icon on the desktop and Scratch will open, ready for you to begin programming. There's no need to create a user account if you use the offline version of Scratch.



△ **Operating system**
The online version of Scratch works well on Windows, Ubuntu, and Mac computers, although it won't work on tablets. The offline version of Scratch works well on Windows and Mac computers. If your computer uses Ubuntu, try the online version instead.



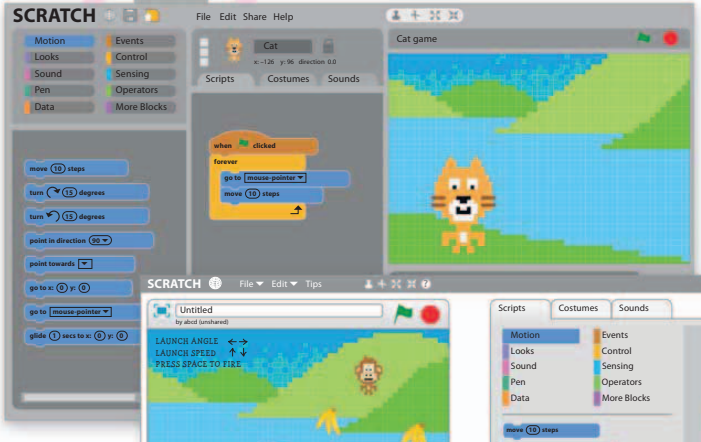
△ **Hardware**
You can use Scratch on desktop or laptop computers, but it's easier if you use a mouse than a touchpad. Scratch apps for tablets and smartphones are also being developed.



◁ **Saving**
If you use Scratch offline, remember to save from time to time. The online version saves automatically. Online, you can undo all the changes you've made since you last opened a project by choosing "Revert" in the File menu.

Old and new versions

This book is based on Scratch 2.0, the latest version at the time of writing. The projects in this book will not work with older versions of Scratch, so make sure you have 2.0.

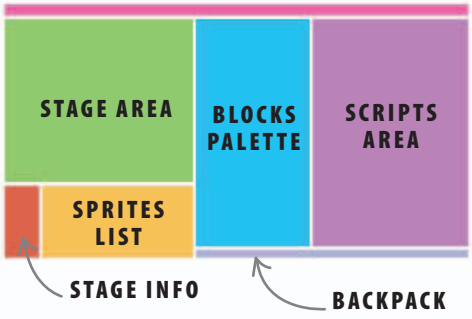


▽ **Version 1.4**
In older versions of Scratch, such as Scratch 1.4, the stage is on the right and the scripts area is in the middle.

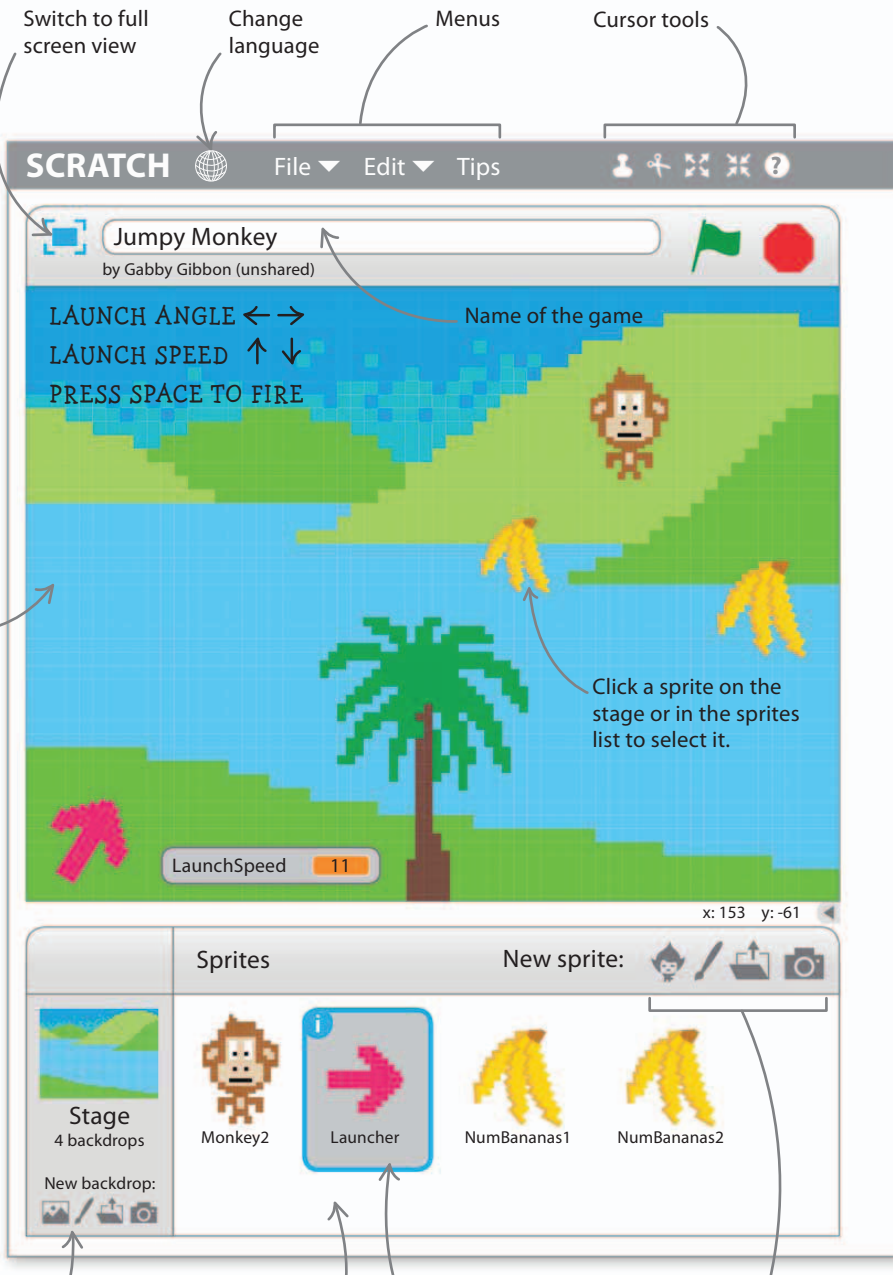
▷ **Version 2.0**
This version of Scratch was released in 2013. New features include a "Backpack" for storing costumes, media, and scripts; a cloning function; a sound editor; and a more sophisticated paint editor.

Scratch tour

The Scratch window is divided into several different areas. Scripts are built on the right, while the stage on the left shows the game running.



△ **Scratch window**
The stage and sprites list occupy the left of the Scratch window, while script-building areas are on the right. The tabs above the scripts area reveal other Scratch features.



The stage
When you play a game or run any other kind of project in Scratch, you see the action happening on the stage, which serves as a miniature screen. You can see changes to your script take effect immediately on the stage simply by clicking the green flag button to run the project.

Click these icons to change the backdrop image on the stage.

Sprites list
All the sprites used in your project appear here. When you select a sprite, its scripts appear in the scripts area.

Selected sprite

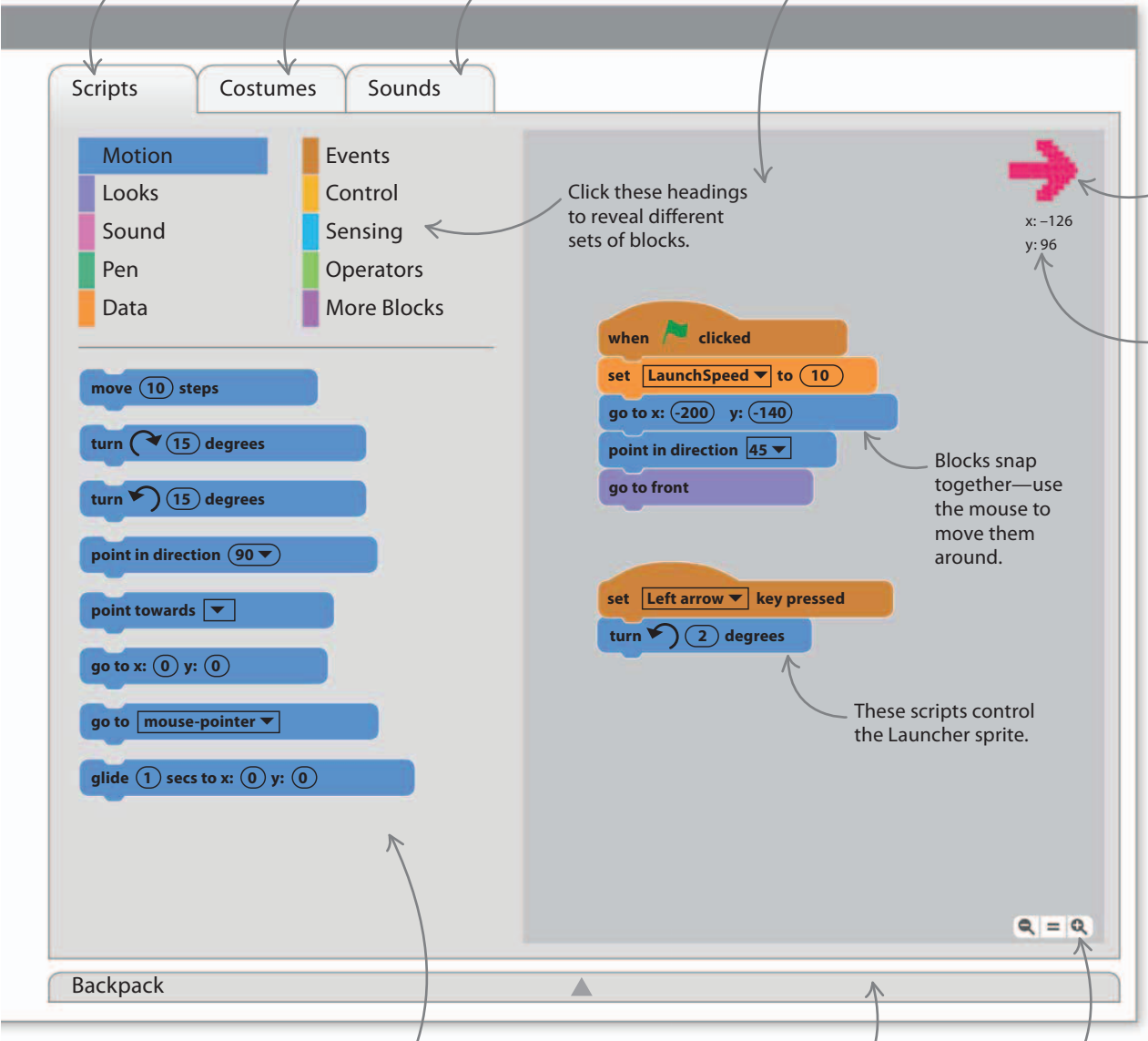
Buttons to add new sprites

Keep the Scripts tab selected to build scripts.

The Costumes tab lets you change how sprites look.

Use the Sounds tab to add music and sound effects to games.

Scripts area
You can drag blocks into this part of the Scratch window and join them together to build scripts for each sprite in your game.



Click these headings to reveal different sets of blocks.

Current sprite selected

The x and y coordinates give the sprite's location on the stage.

Blocks snap together—use the mouse to move them around.

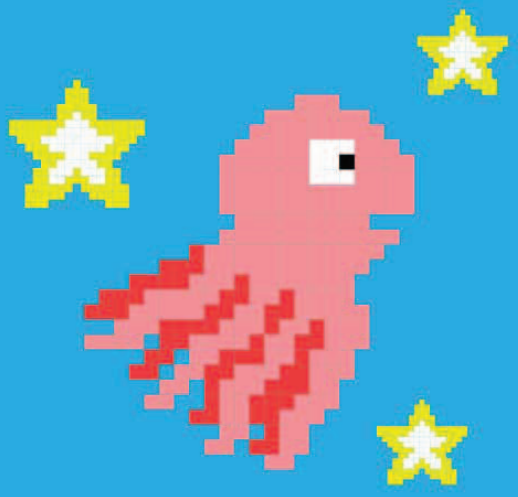
These scripts control the Launcher sprite.

Blocks palette
Instruction blocks for making scripts appear in the middle of the Scratch window. Drag the ones you want to use to the scripts area.

Backpack
Store useful scripts, sprites, costumes, and sounds in the backpack so you can use them in other projects.

Zoom in on scripts

Star Hunter



How to build Star Hunter

Welcome to your first Scratch game: Star Hunter, a fast-paced, underwater treasure hunt. Just follow the simple steps in this chapter to build the game, then challenge a friend to beat your score.

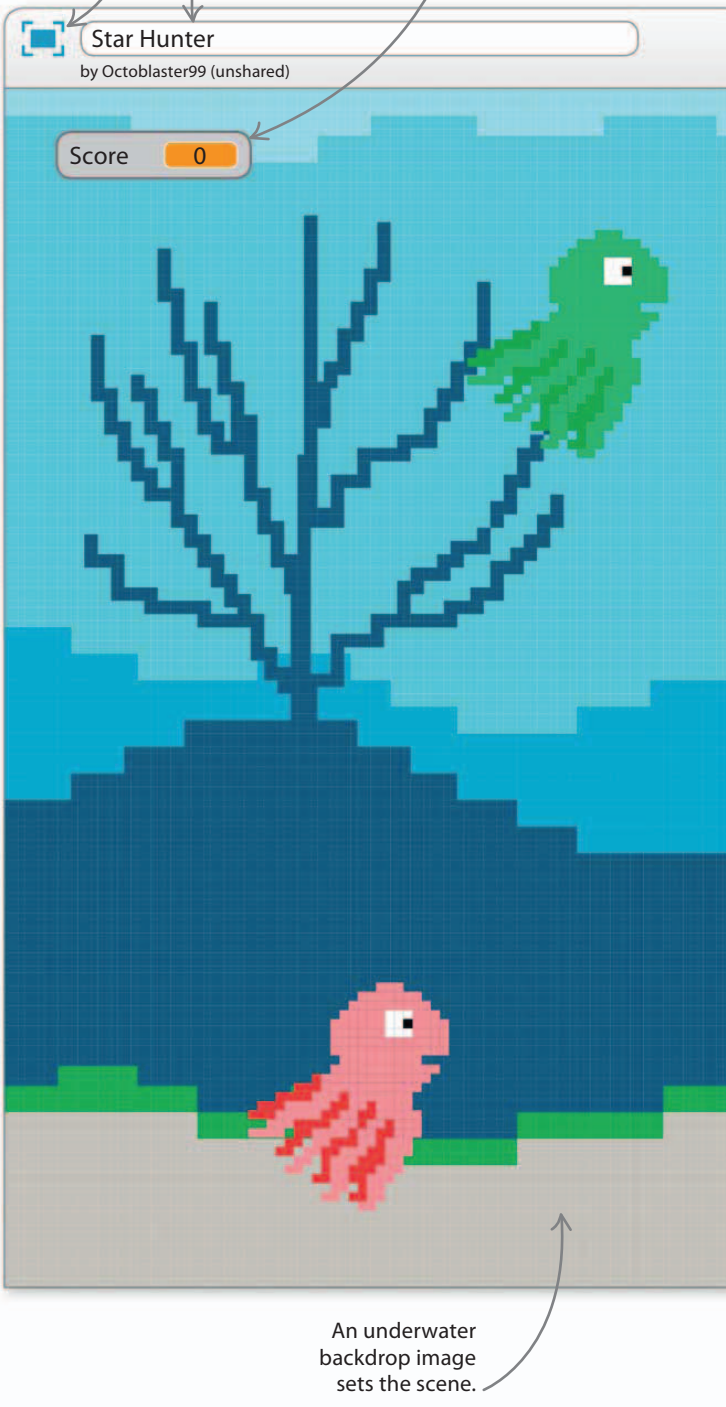
AIM OF THE GAME

The aim of this game is to collect as many gold stars as you can. Use the cat to collect the stars, but watch out for deadly octopuses. You'll need to move quickly to succeed. The main sprites in the game are shown below.

◁ **Cat**
Move the cat around the screen with your computer mouse—the cat sprite follows the mouse-pointer.

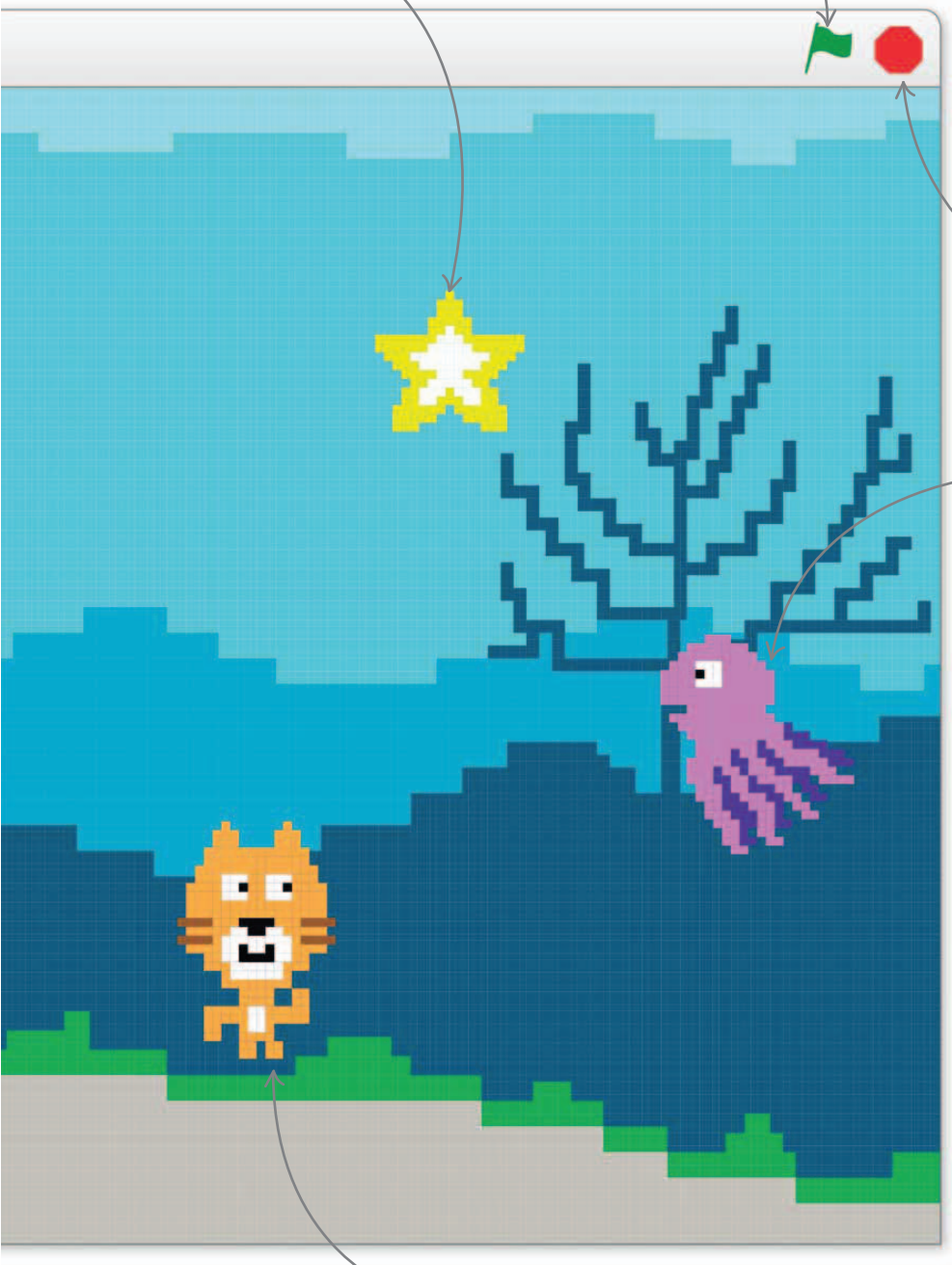
◁ **Octopuses**
The octopuses patrol the seas but they swim more slowly than you. If you touch one, the game is over!

◁ **Stars**
These appear one at a time in random places. Touch a star to score a point.



Click the green flag to start a new game.

Collect stars to score points.



Click the stop sign to end a game.

Don't touch the octopuses! There are three octopuses and they move in different ways.

You play the game as a cat. Move your computer mouse to move the cat.

GAME CONTROLS

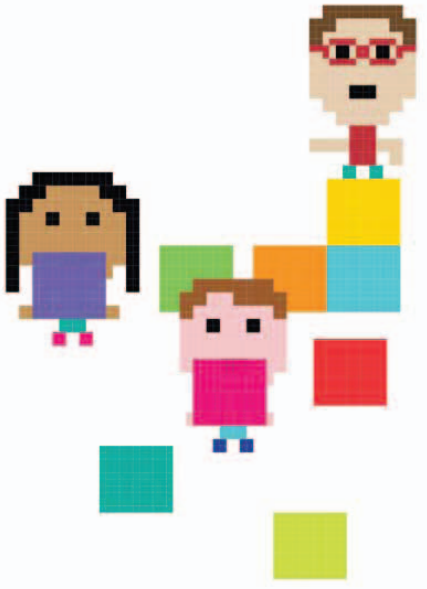
Use a computer mouse or touchpad to control this game.

◁ **Under the sea**

Star Hunter is set in the deep sea, but you can change the backdrop to anything you like, from outer space to a picture of your bedroom.

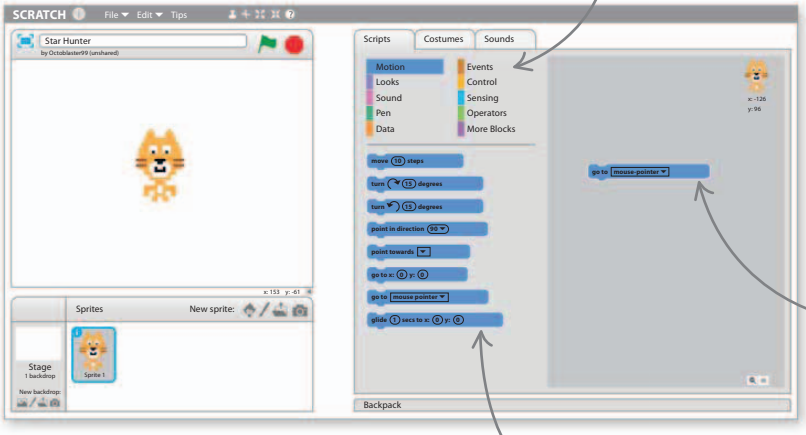
Building scripts

Like any Scratch program, Star Hunter is made by joining colored blocks like the pieces of a jigsaw puzzle. Each block is an instruction that tells a sprite what to do. Let's start by programming the game's main sprite: the cat.



1 Start Scratch and choose either "create" or "New Project". You'll see a screen like the one below, with the cat sprite in place. In the middle is a set of blue instruction blocks.

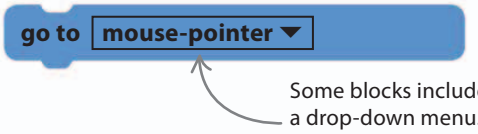
Clicking the buttons here reveals different sets of blocks.



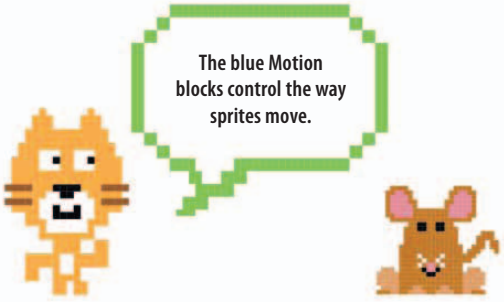
Drag your chosen blocks here to build a script.

Choose blocks from the list in the middle.

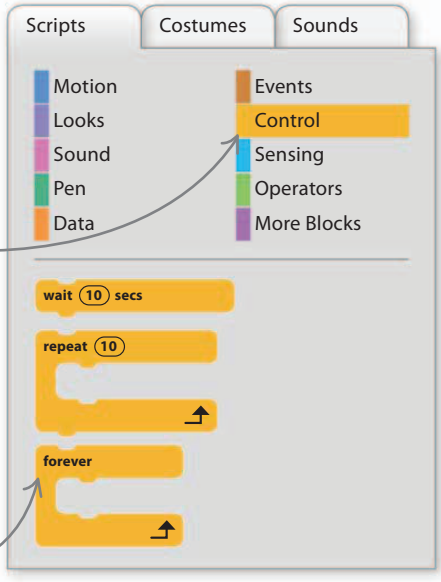
2 We'll program the cat to move wherever the player moves the computer mouse. Click on the "go to mouse-pointer" block and drag it to the right part of the screen—the scripts area.



Some blocks include a drop-down menu.



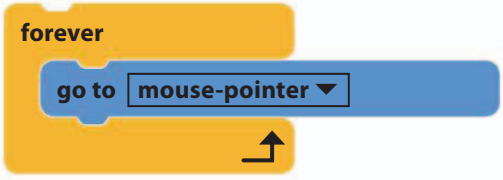
3 Now select the yellow Control button and look for a "forever" block.



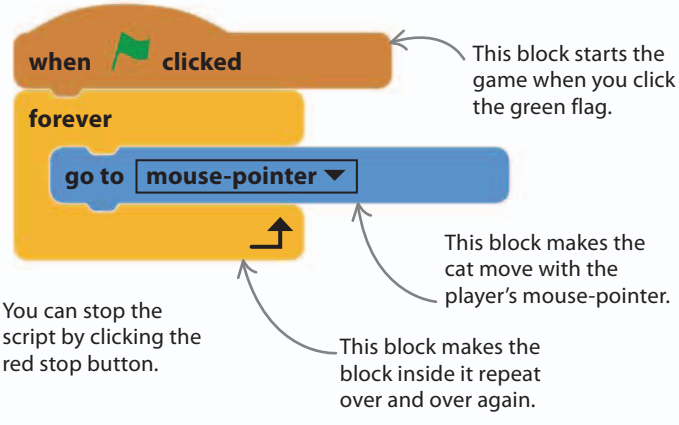
Click Control to reveal the yellow blocks.

Drag the "forever" block to the scripts area.

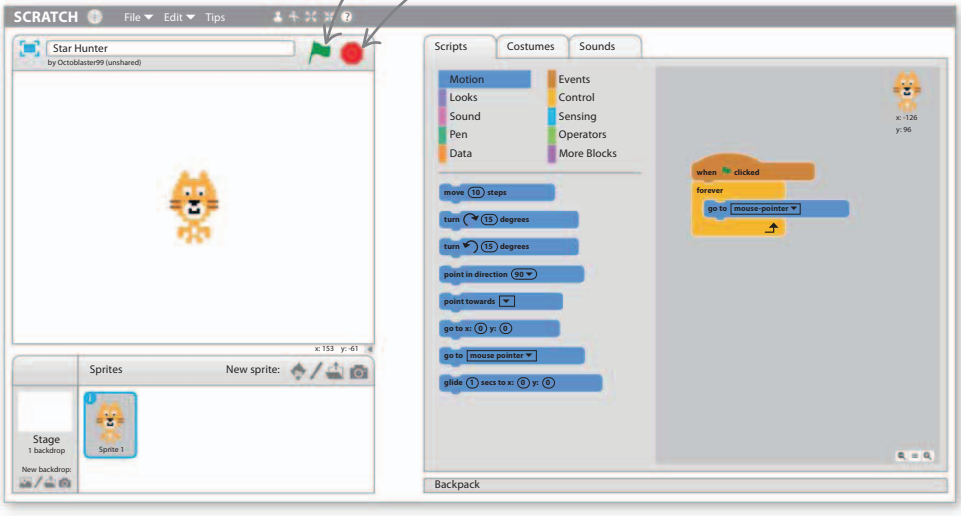
4 Drag it to the right and drop it over the blue block. It will wrap around it like this:



5 Next, select the brown Events button. Look for a block with a green flag. Drag it to the right and add it to the top of your script. Read through the script and think about what each block does.



6 Now look at the top right of the stage—you'll see a green flag. Click this to run your script.

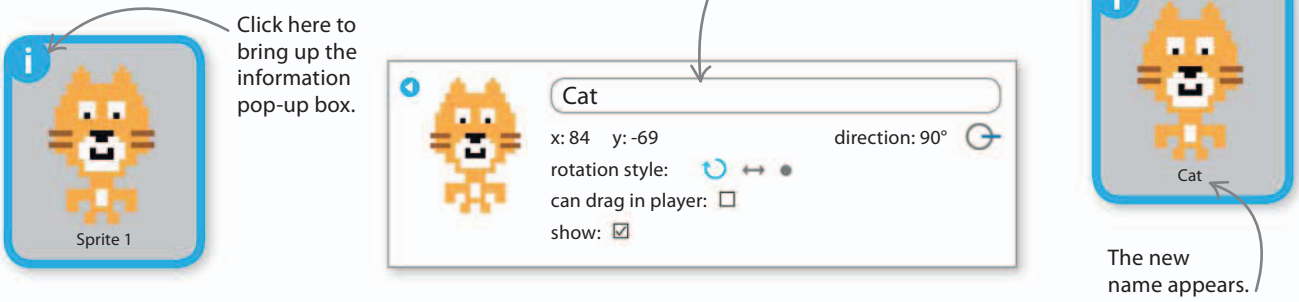


7 Move your mouse and watch what happens. If you followed all the steps, the cat will move with the mouse-pointer around the stage.

▷ **Well done!**

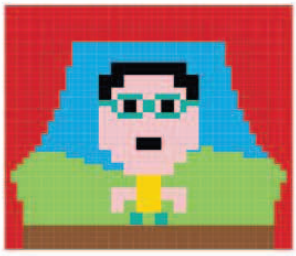
You have created your first Scratch project. Let's add some more things to the project to build a game.

8 The cat is called "Sprite1". Let's fix that. In the sprites list, select Sprite1 (the cat) and click on the blue "i" in the corner to get more information about the sprite. Change the name to "Cat".

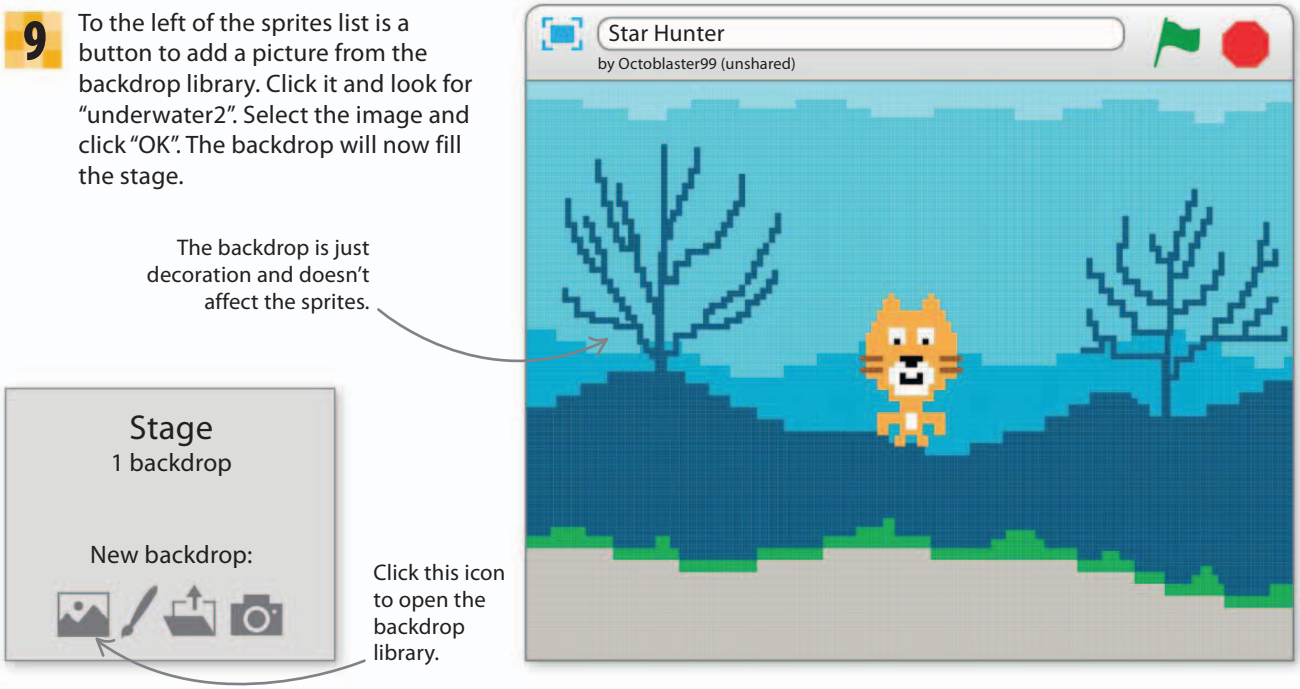


Setting the scene

At the moment, the stage is just a boring white rectangle. Let's create some atmosphere by adding scenery and sound effects. To change the scenery, we add a "backdrop" image.



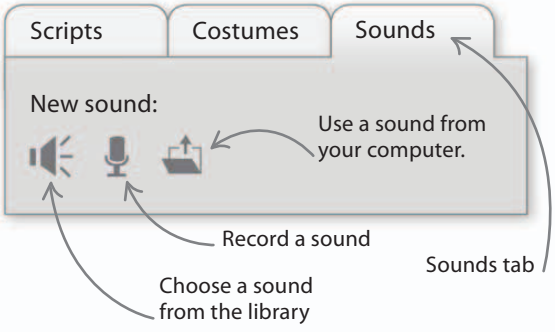
9 To the left of the sprites list is a button to add a picture from the backdrop library. Click it and look for "underwater2". Select the image and click "OK". The backdrop will now fill the stage.



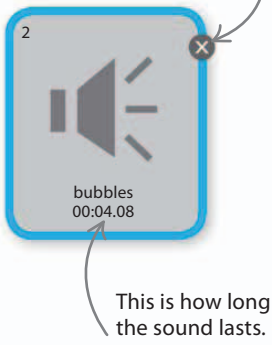
Sound effects

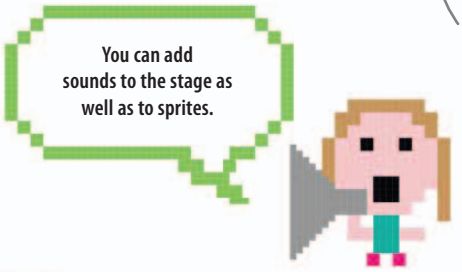
Now we'll add a bubbling sound to the cat sprite to make it sound like we're underwater.

10 Highlight the cat in the sprites list and then click the Sounds tab above the blocks palette. Click the speaker icon to choose a sound from the library.

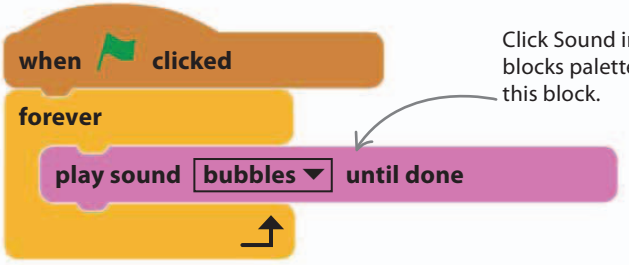


11 Look for "bubbles" in the library. You can preview sounds by clicking the play symbol. To load a sound into the game, click the speaker icon and then "OK". Now you'll see bubbles in your list of sounds.





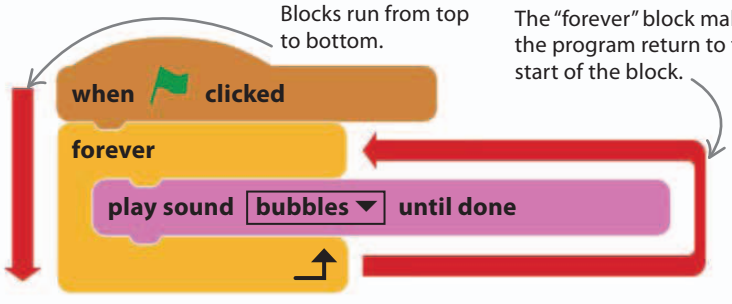
12 Click the Scripts tab and add the following script to the cat sprite, but leave the old script in place because you need both. The new script repeats the bubbles sound. The "play sound ... until done" block waits for the sound to finish before letting it start again. Run the game to hear the sound effect.



EXPERT TIPS

Loops

A loop is a section of code that repeats over and over again. The "forever" block creates a loop that carries on forever, but other types of loop can repeat an action a fixed number of times. Loops are very common in almost all computer programming languages.

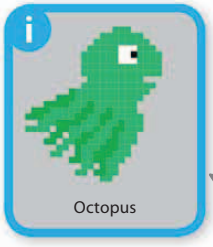


Add an enemy

The game needs an enemy to make things more interesting. Let's add an octopus with a deadly sting. The octopus will patrol the stage, moving left and right, and the player will have to keep out of its way or the game is over.

13 To add a second sprite to the project, click the icon shown below to open up the sprite library. Choose the octopus and click "OK".

Click here to open the sprite library.

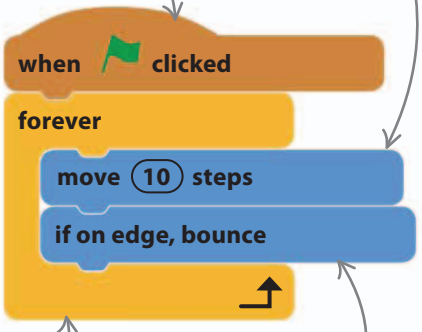


The octopus sprite will appear in your sprites list.

14 Add the following script to the octopus sprite. To find the blue blocks, click on Motion in the blocks palette. The two Motion blocks used here make the octopus move left and right across the stage.

This block runs the script when the game begins.

Motion blocks are dark blue and control the way sprites move.

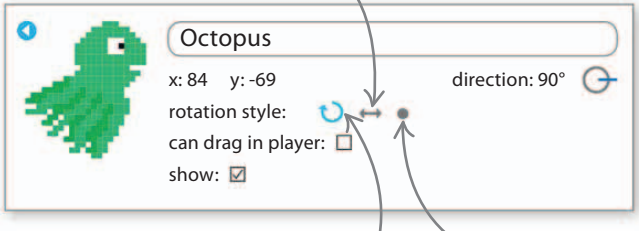


The "forever" block repeats everything inside.

This block stops the octopus from moving off the edge of the stage.

15 Now run the script. The octopus will patrol left and right, but you'll notice it's upside down half the time. We can fix this by changing the way the sprite turns around when it changes direction. Highlight the octopus and click the blue "i". In the pop-up box, there are three options after "rotation style".

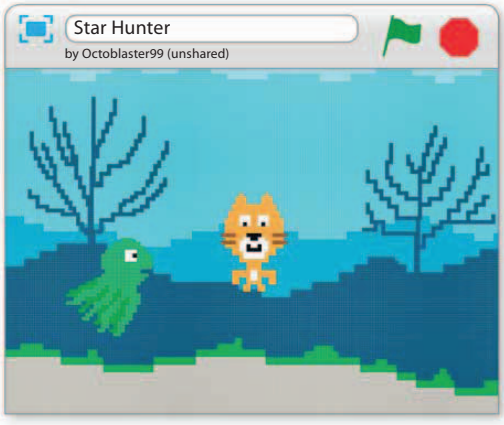
The middle option makes the sprite flip sideways when it bounces.



The left option makes the sprite turn upside down when it bounces.

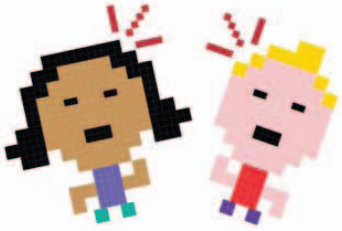
The right option makes the sprite bounce without turning round.

16 Choose the middle option and run the project. The octopus should now stay right side up and facing forward all the time. You can adjust its starting position on the screen by dragging it with the mouse.

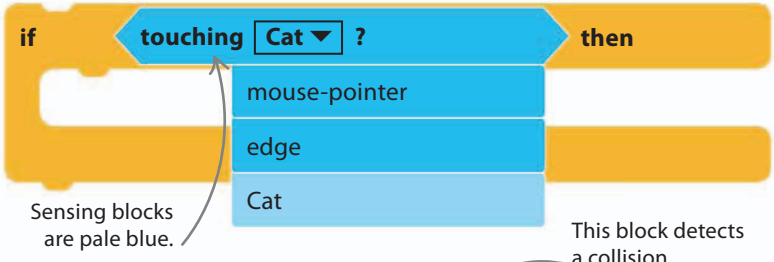


Collisions

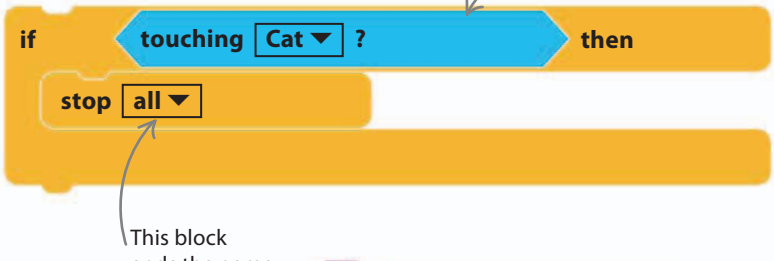
So far the octopus and cat move through each other without anything happening. We need to add a script to make them stop moving when they collide. Collision detection is very important in computer games.



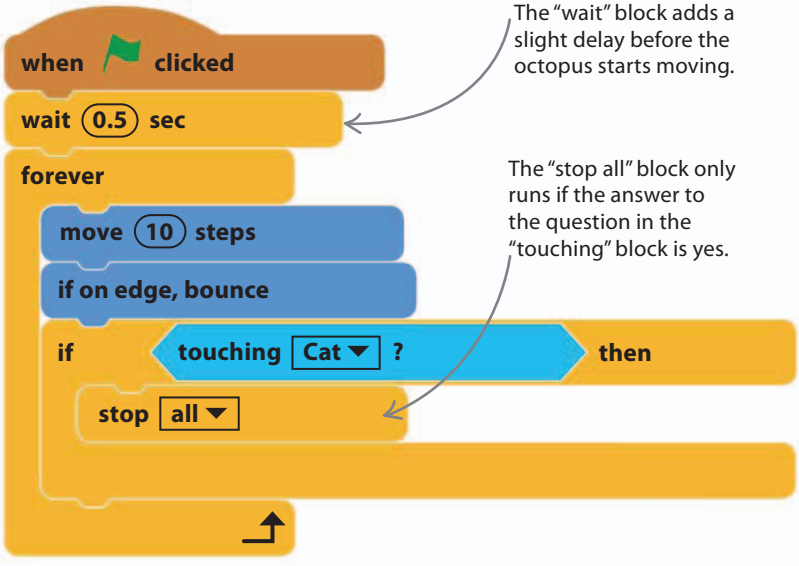
17 Highlight the octopus and drag a yellow "if then" block to an empty part of the scripts area. Now add a pale blue "touching" block to the top of the "if then" block. Click the drop-down menu and choose "Cat". This script will help the octopus detect the cat.



18 Choose Control in the blocks palette again, and add a "stop all" block to the middle of the "if then" block. This will stop all action if the octopus is touching the cat, ending the game.



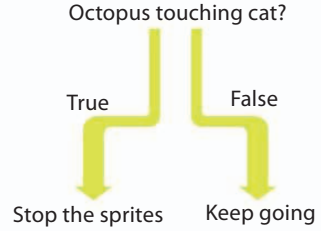
19 Now add the "if then" blocks you've built to the octopus's main script, placing it carefully after the blue Motion blocks. Also, add a "wait 0.5 sec" before the loop. Run the project and see what happens.



EXPERT TIPS

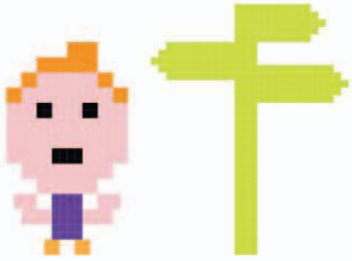
"if then"

You make decisions every day. If it's raining, you might use an umbrella. If it isn't, you don't. Computer programs do the same thing by using what programmers call conditional statements, such as "if then". When Scratch reaches an "if then" block, it runs the blocks inside only if the statement is true.



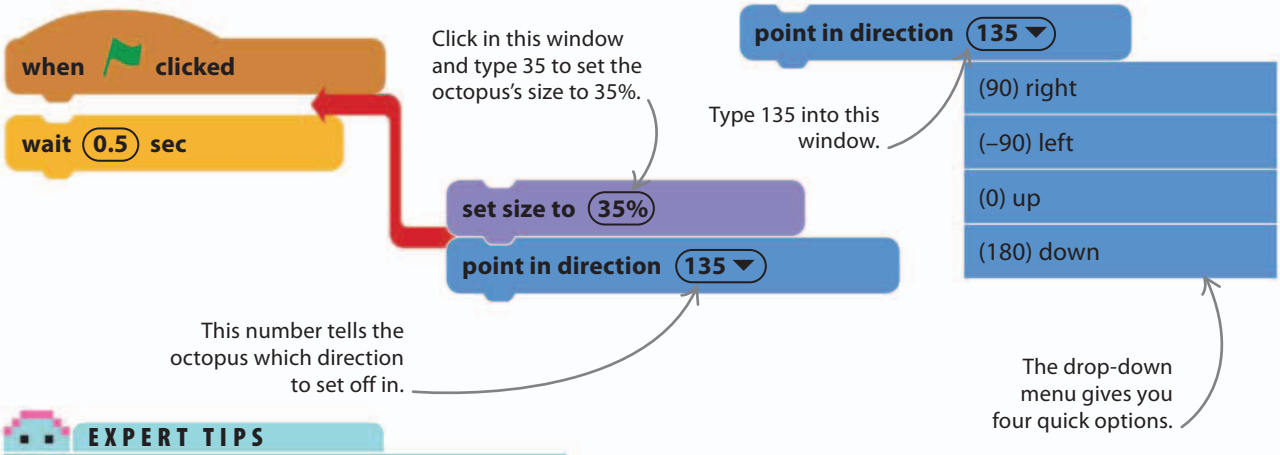
More enemies

Let's add more enemies to the game, but to make things more challenging, we'll make them move in different directions. We can tell each sprite exactly which way to go by using a block that works like a compass.



20 Add a purple "set size" block to the top of the octopus's script, after the "when clicked" block. Set the octopus's size to 35% to make the game a bit easier. Then add a blue "point in direction" block.

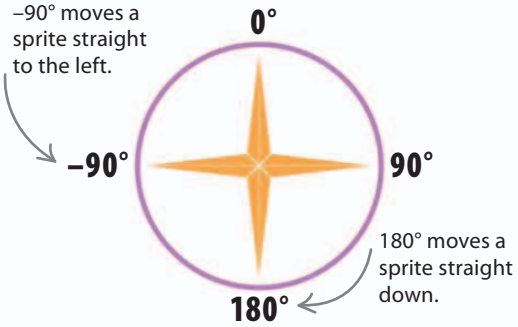
21 To change the octopus's direction, click on the window in the "point in direction" block and type 135 in place of 90. This will make the octopus move diagonally.



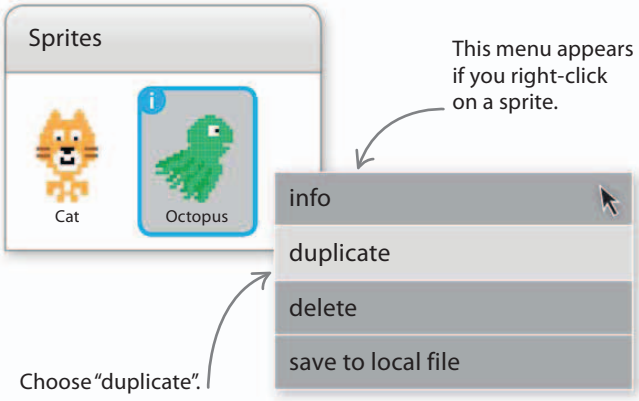
EXPERT TIPS

Directions

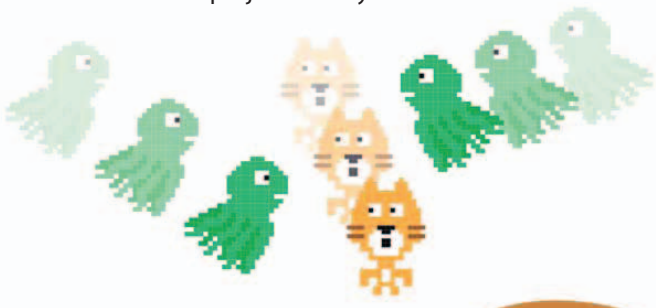
Scratch uses degrees to set direction. You can choose any number from –179° to 180°. Negative numbers point sprites left; positive numbers point them right. Use 0° to go up and 180° to go straight down.



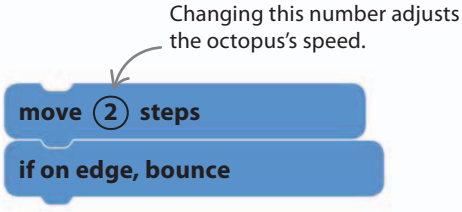
22 Now we can duplicate our octopus to create more enemies. Right-click on the octopus in the sprites list (or control-click if you have a Mac) and choose "duplicate". Copies of the Octopus sprite will appear in the sprites list, named Octopus2 and Octopus3. Each will have a copy of the first octopus's script.



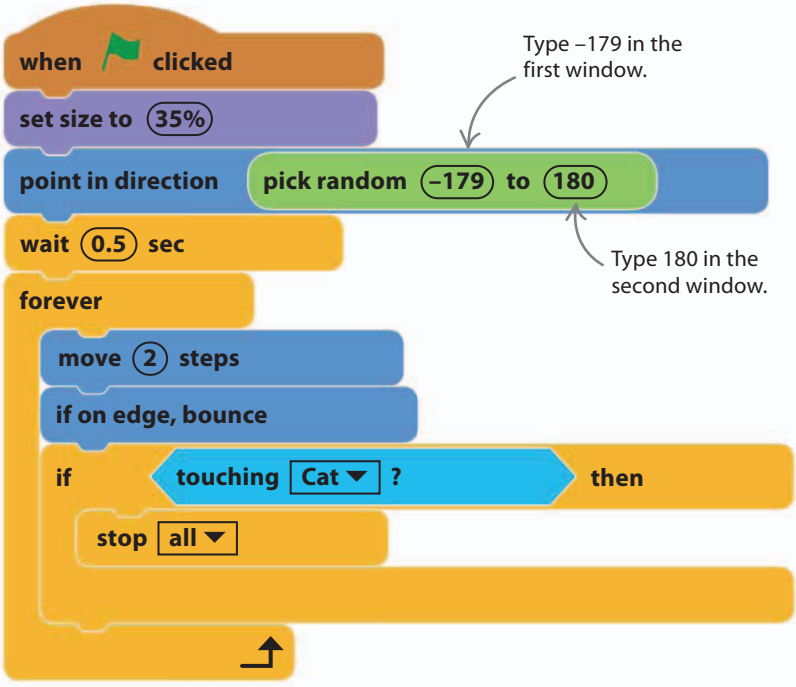
23 To make the octopuses move in different directions, change the number in the "point in direction" block for each new octopus. Leave the first Octopus sprite's direction as 135, but set Octopus2 to 0 and Octopus3 to 90. Run the project and try to avoid all the enemies.



24 If it's too hard to stay alive, make the octopuses slower by lowering the number of steps in their "move" blocks to two. Remember to change the script for all three octopus sprites.



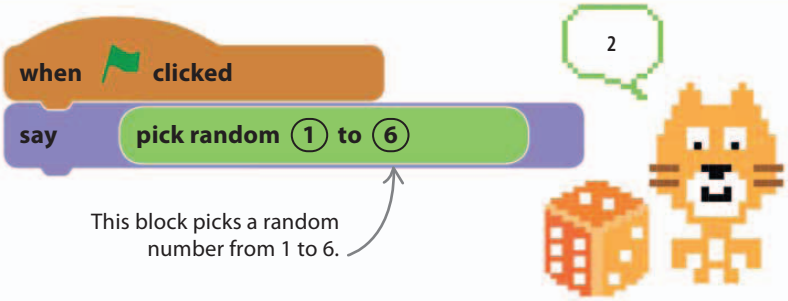
25 For more variety, let's make one of the octopuses set off in a random direction. To do this, we use a green "pick random" block. This is Scratch's way of rolling a dice to generate a random number. Choose Operators in the blocks palette to find the block and add it to the first octopus's script. Run the project a few times to see the octopus choose different starting directions.



EXPERT TIPS

Random numbers

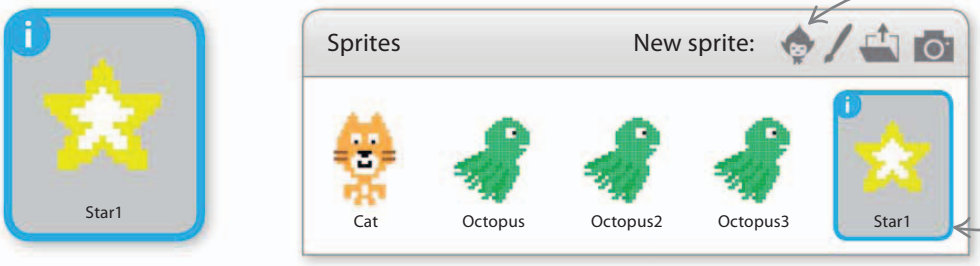
Why do so many games use dice? Dice create surprises in a game because they make different things happen to each player. A random number is one you can't predict in advance, just like the roll of a dice. You can get the cat to say a random dice roll using this simple code.



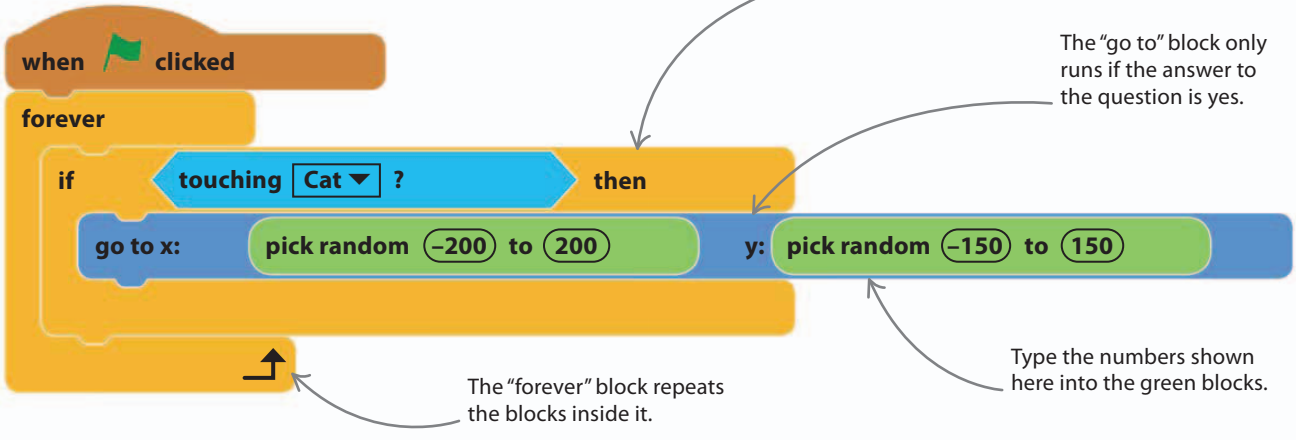
Collecting stars

In many games, the player has to collect valuable items to win points or to stay alive. In Star Hunter, we use gold stars as underwater treasure that the player has to collect. We'll use random numbers again to make each star appear in a new place.

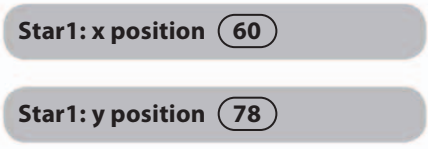
26 Click the "choose new sprite" symbol in the sprites list and choose the "Star1" sprite from the library.



27 Add the following script to Star1. This script will make the star move to a random new location whenever the cat touches it. The green blocks create random numbers called coordinates, which Scratch uses to pinpoint locations on the stage.



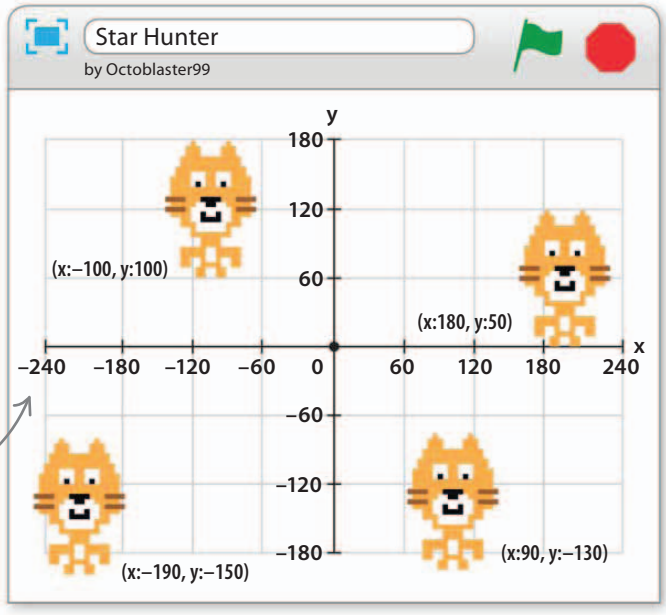
28 To see the star's coordinates change when it moves, choose Motion in the blocks palette and put ticks by "x position" and "y position". Now run the game: you'll see the star's x and y coordinates update each time the cat makes it move. Untick both boxes before you carry on.



EXPERT TIPS

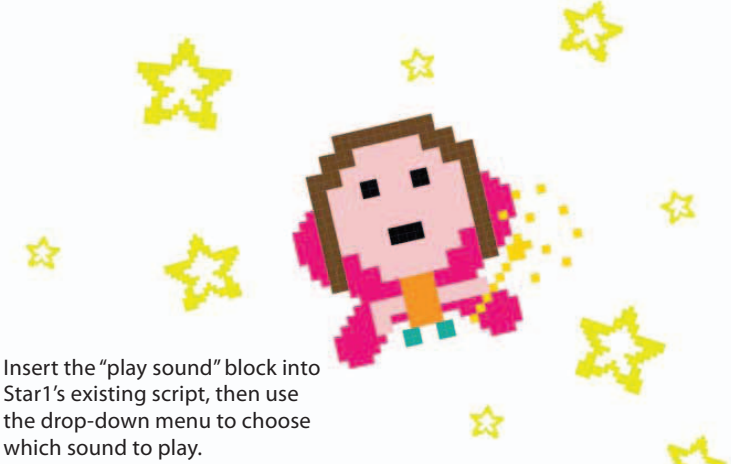
Using coordinates

To pinpoint a location on the stage, Scratch uses numbers called coordinates. These work just like graph coordinates, with x numbers for horizontal positions and y numbers for vertical. To find the coordinates for a spot on the stage, just count the steps across and up from the center of the stage. Positive coordinates are up or right, negative coordinates are down or left. Every spot on the stage has a unique pair of coordinates that can be used to send a sprite to that position.

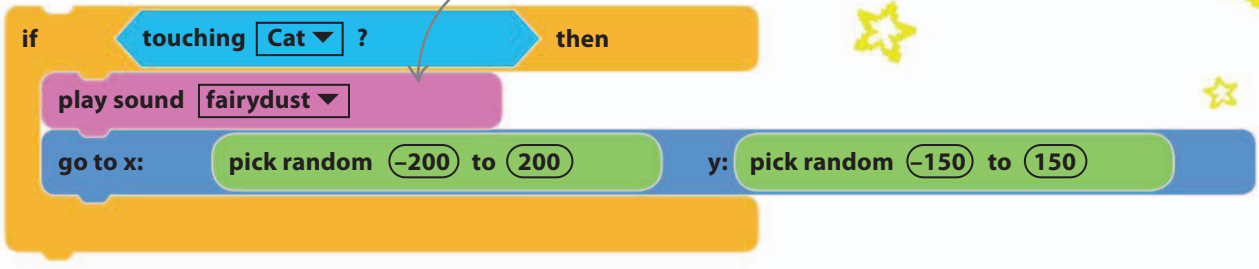


The x axis is longer than the y axis and extends from −240 to 240.

29 You can add a sound effect that plays when the cat touches a star. First make sure that the star is selected in the sprites list, then click the Sounds tab above the blocks palette. Click the speaker symbol to open the sound library. Choose "fairydust" and click "OK". Now add the pink "play sound" block to the star's script and choose "fairydust" in the drop-down list.



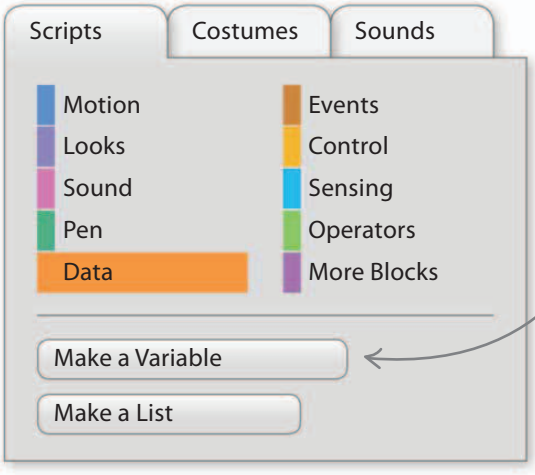
Insert the "play sound" block into Star1's existing script, then use the drop-down menu to choose which sound to play.



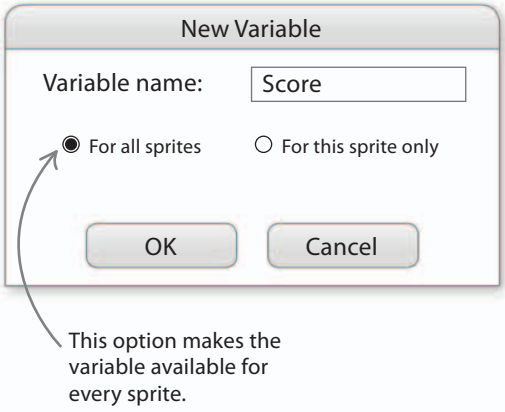
Keeping score

Computer games often need to keep track of vital statistics such as the player's score or health. We call these changing numbers "variables". To keep track of the player's score in Star Hunter, we'll create a variable that counts the number of stars the player has collected.

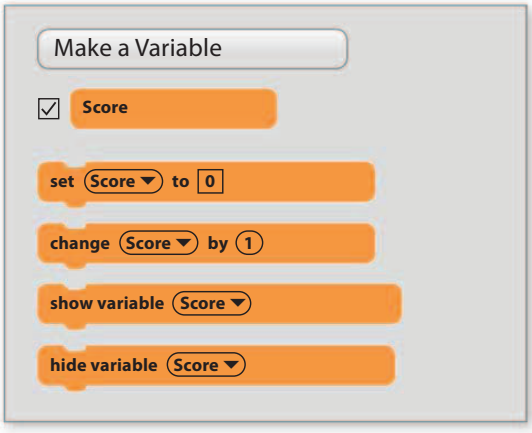
30 With any sprite selected, choose Data in the blocks palette. Click on the button "Make a Variable".



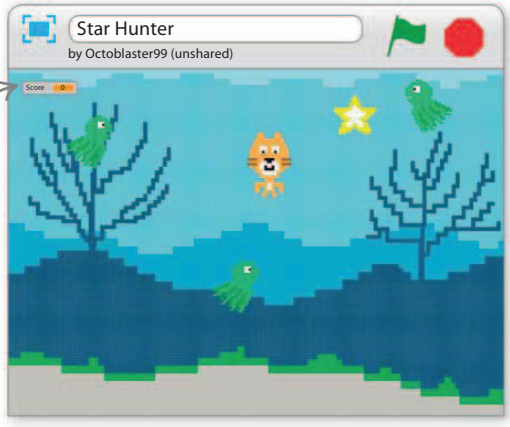
31 A pop-up box appears asking you to give your variable a name. Type "Score" in the box. Make sure the option "For all sprites" is selected and hit "OK".



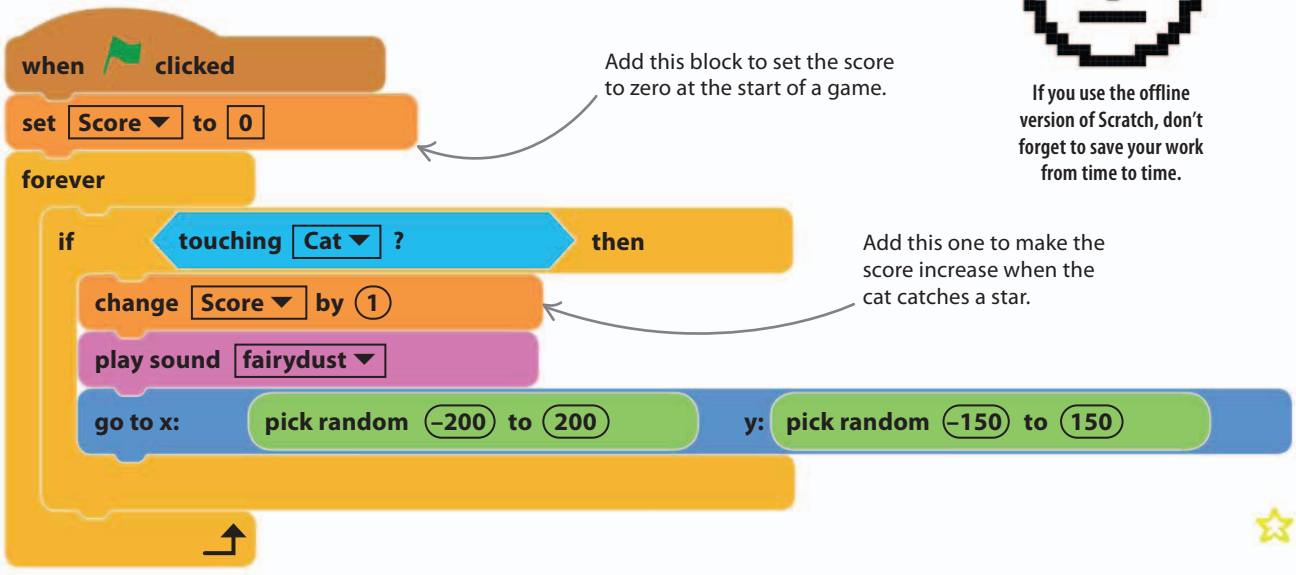
32 You'll see a new set of blocks appear, including one for the score. Make sure the box next to it is checked to make the score appear on the stage.



33 The score counter will appear in the top left of the stage but you can drag it anywhere you like.



34 We want the score to start at zero and increase by one each time the cat touches a star. Select the star sprite and add the two orange Data blocks below to its script.



Add this block to set the score to zero at the start of a game.

Add this one to make the score increase when the cat catches a star.

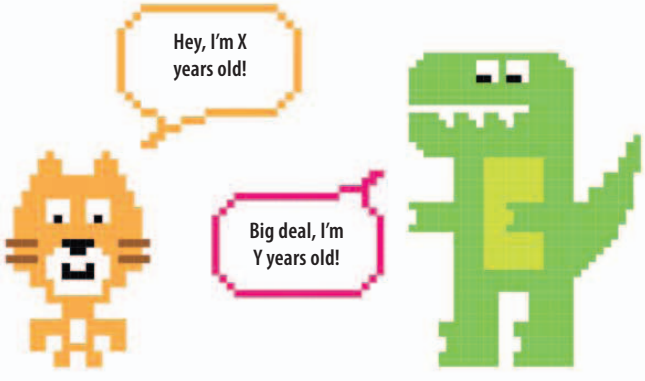
If you use the offline version of Scratch, don't forget to save your work from time to time.

35 Now click the green flag to run the script and see what happens when the cat collects each star. See if you can collect 20 stars without bumping into an octopus.

EXPERT TIPS

Variables

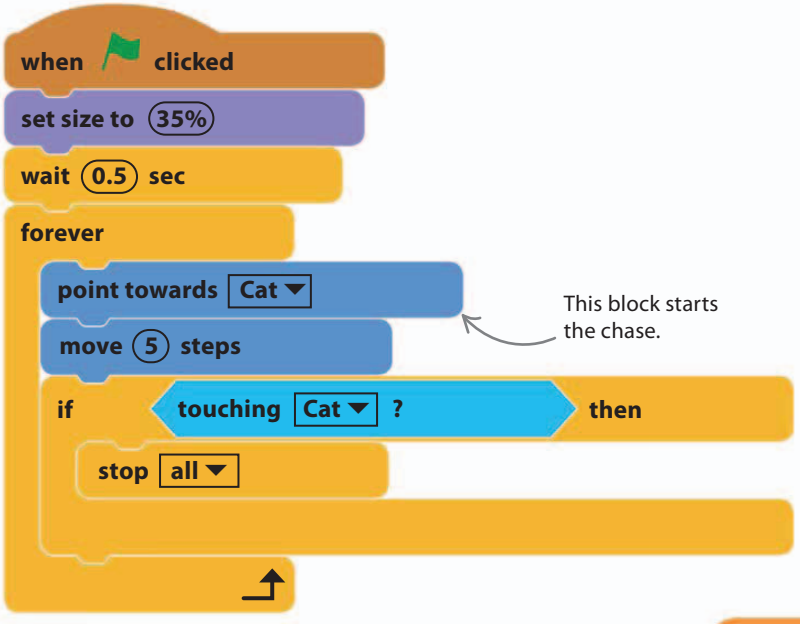
A variable works like a box that you can store information in, such as a number than can change. In math, we use letters for variables, such as x and y. In computer programming, we give variables names such as "Score" and use them for storing not just numbers but any kind of information. Try to choose a name that tells you what the variable is for, such as "Speed" or "Score". Most computer languages won't let you put spaces in the names of variables, so a good tip is to combine words. Instead of using "dog speed", for instance, type "DogSpeed".



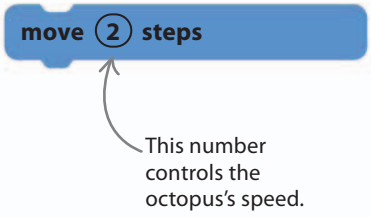
Better enemies

Now we have a working game, we can test it and experiment with changes that make it easier, harder, or—most important—more fun. One way to make the game more interesting is to make the three octopuses do different things.

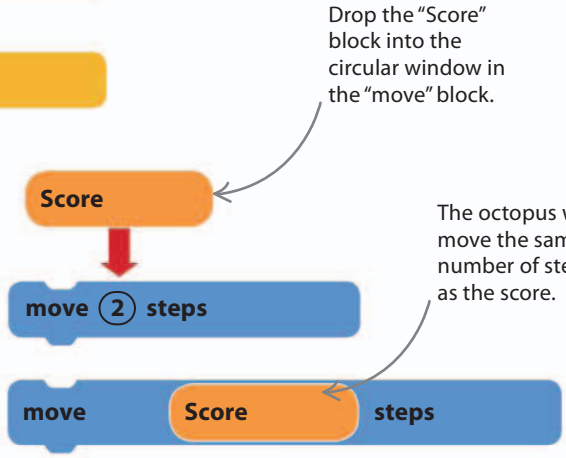
36 Right-click the script for Octopus2 and select "delete" to remove it. Replace it with the following script. This will make the octopus chase the cat.



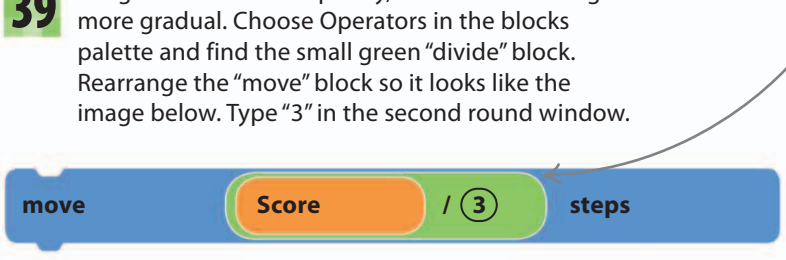
37 Run the project and see how the game plays. You'll probably find it hard to escape the octopus because it moves quickly. To slow it down, change the number of steps to two.



38 You can make the game get harder as you play. Select the original octopus sprite and click Data in the blocks palette. Drag the "Score" block into the octopus's "move" block. Now try the game. The more points you get, the faster the octopus swims.

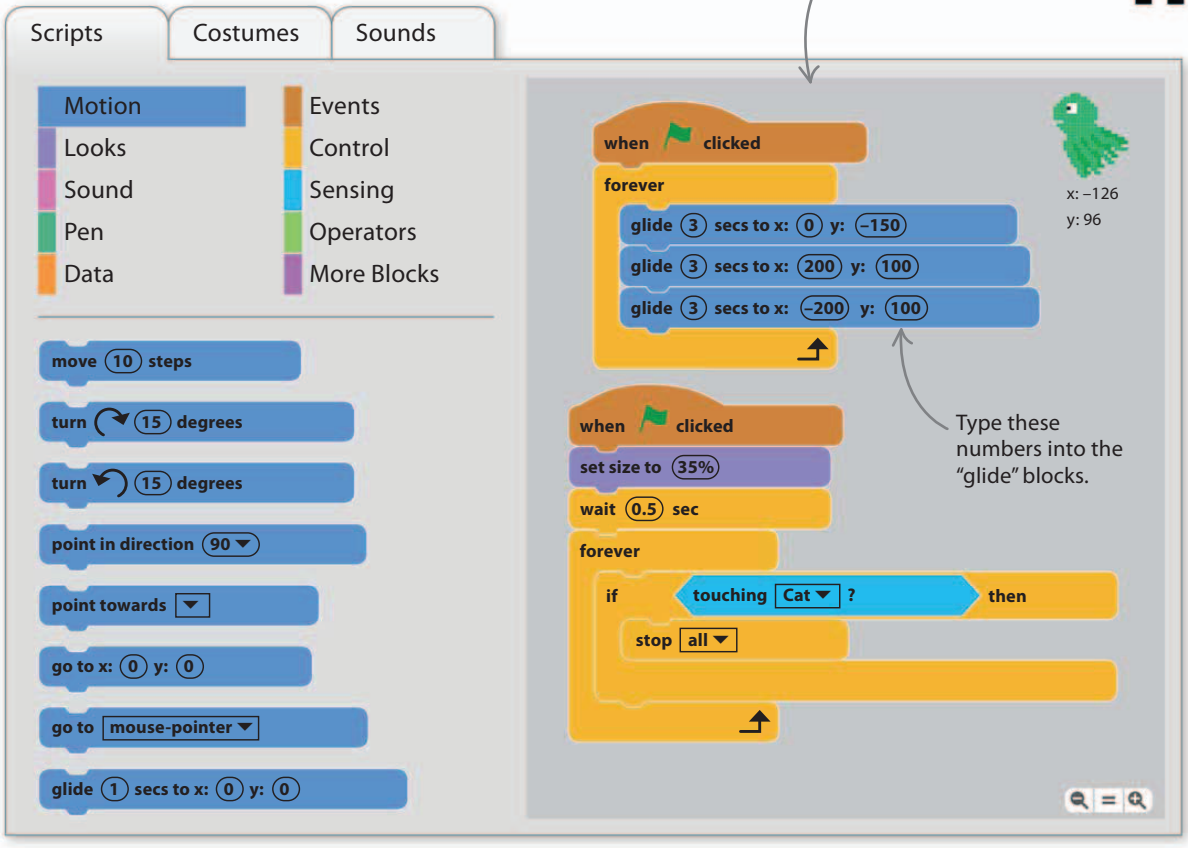


39 If it gets too hard too quickly, we can make things more gradual. Choose Operators in the blocks palette and find the small green "divide" block. Rearrange the "move" block so it looks like the image below. Type "3" in the second round window.

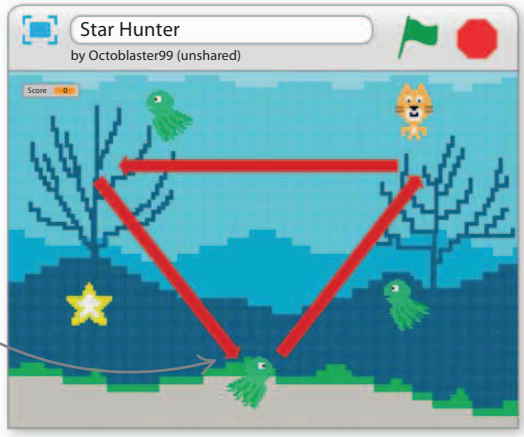


40 Now we'll make Octopus3 patrol in a regular pattern. To do this, we'll use a new Motion block that makes it glide smoothly from point to point, rather than moving in steps. Replace the script for Octopus3 with the following two scripts. These run at the same time, one checking for collisions and the other moving the octopus around its patrol route.

The two scripts are separate in the scripts area.



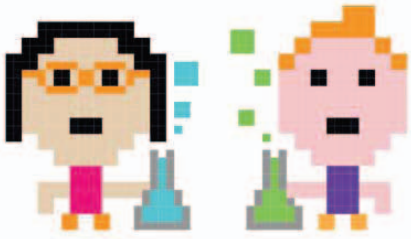
41 Now run the project and watch Octopus3. It should swim in a repeating triangle pattern.



To change the shape of the triangle, try different numbers in the "glide" blocks.

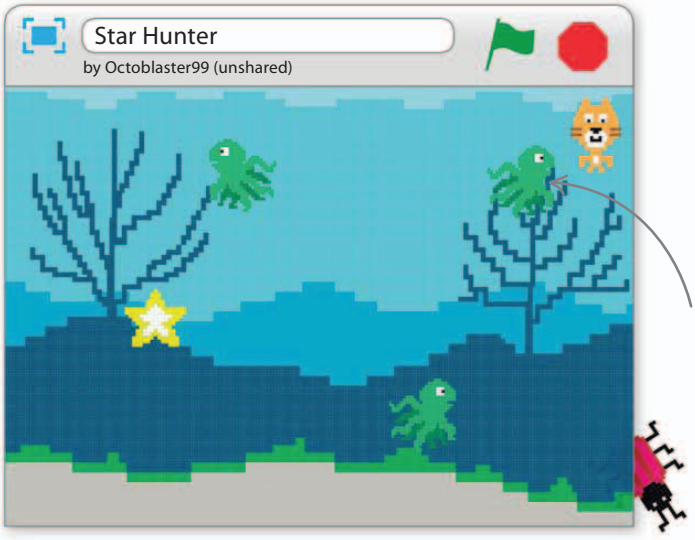
Hacks and tweaks

You've built a fun game, but that's just the beginning. Scratch makes it easy to change and adapt games as much as you want. You might find bugs that need fixing, or you might want to make the game harder or easier. Here are some suggestions to get you started.

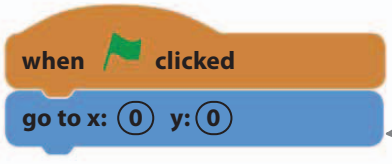


▽ Debug Octopus2

If Octopus2 ends up in the top-right corner at the end of a game, it can trap the player in the next game and end it too quickly. This is a bug. To fix it, you could drag the octopus away from the corner before starting, but it's better to use a script that moves it automatically. Insert a "go to" block at the start of the script for Octopus2 to send it to the center of the stage.



Octopus2 can trap the player in the top-right corner.

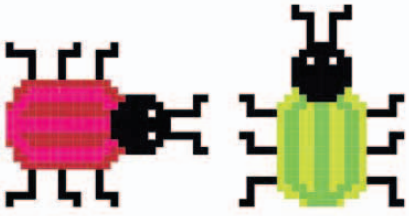


Add this block to make Octopus2 start in the center of the stage.

LINGO

Bugs

A bug is an error in a program. The first computers made mistakes when real insects, or bugs, got in their circuits. The name stuck. Today, programmers often spend as much time finding and fixing bugs as they do writing code in the first place.

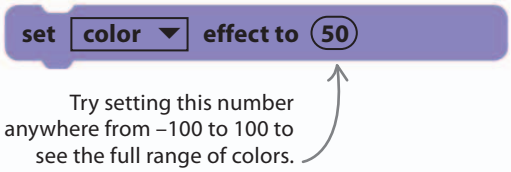


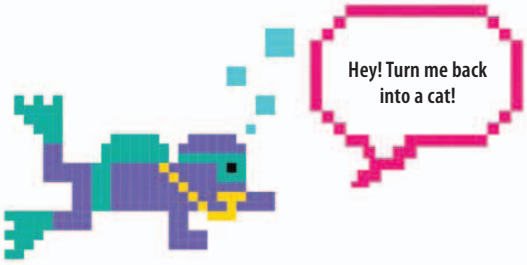
△ Fine-tuning

The best games have been carefully tested to make sure they play well. Test every change you make and get friends to play your games to see how well they work.

▽ Different colors

Make your octopuses different colors by using the "set color" block from the Looks section. Place it under the "set size" block at the start of the script.



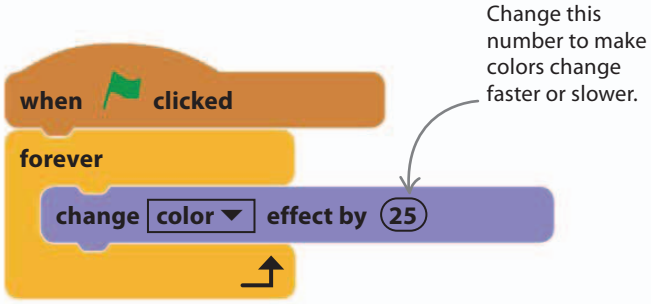


△ Scuba diver

To make the underwater theme more convincing, replace the cat with a diver. Click on the cat in the sprites list, then open the Costumes tab and click on the sprite symbol to open the library. Load the costume called "diver1".

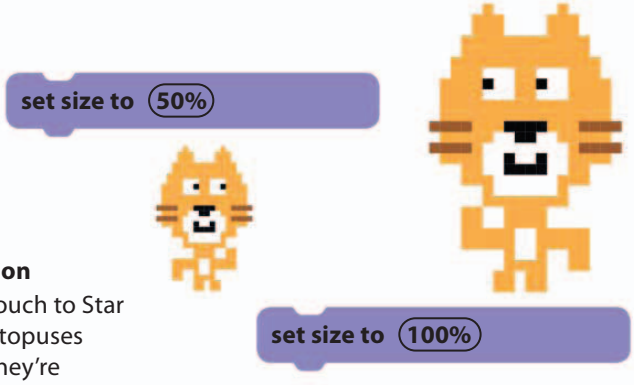
▽ Flashing colors

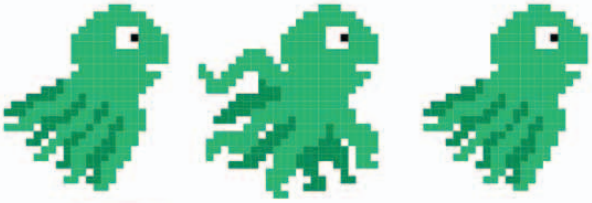
You can make an octopus change color continually to create a flashing effect. Add the script below to any octopus. Try experimenting with different numbers in the "change color" block.

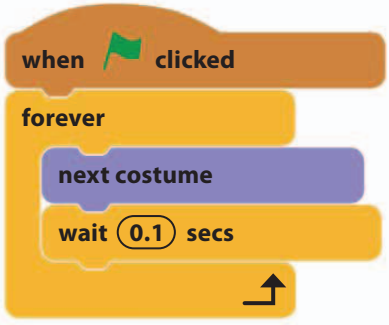


▽ Play with size

You can change how easy the game is by adjusting the size of the sprites. Change the number in the octopuses' blue "move" blocks to alter their speed. Change the purple "set size" blocks to make sprites larger or smaller. Fine-tune the numbers until the game is just hard enough to be fun.

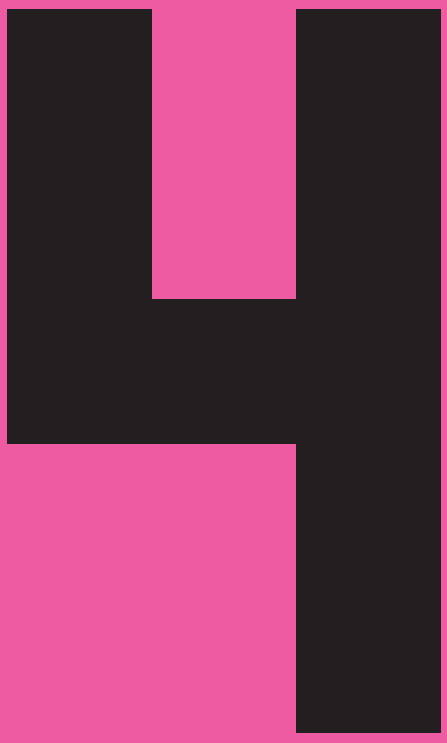






◁ Swimming animation

To add a professional touch to Star Hunter, animate the octopuses so that they look as if they're swimming. Add this script to an empty part of the scripts area for each octopus to make them switch between two different poses.



Cheese Chase

How to build Cheese Chase

Some of the world's first and most popular computer games were maze games. In a maze game, quick thinking is essential as you race around tight corners, avoiding monsters and collecting treats.

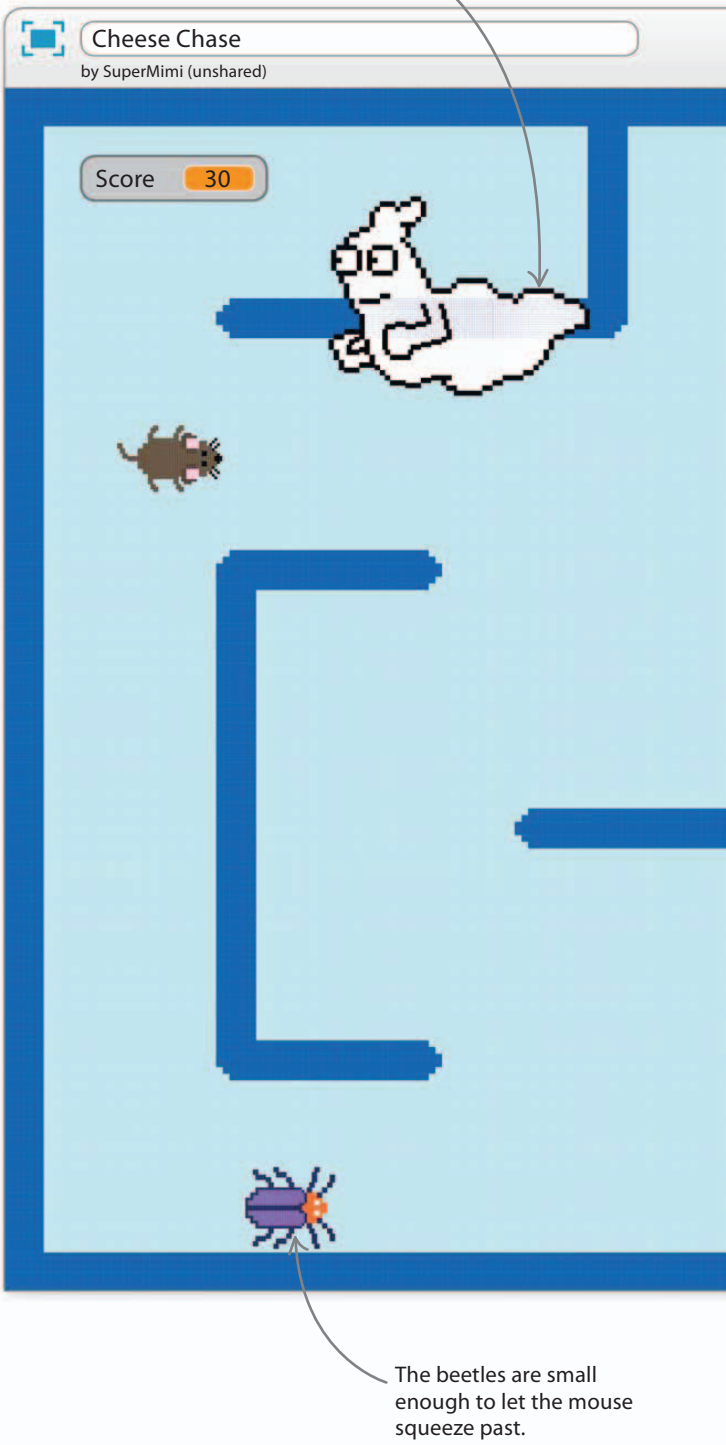
AIM OF THE GAME

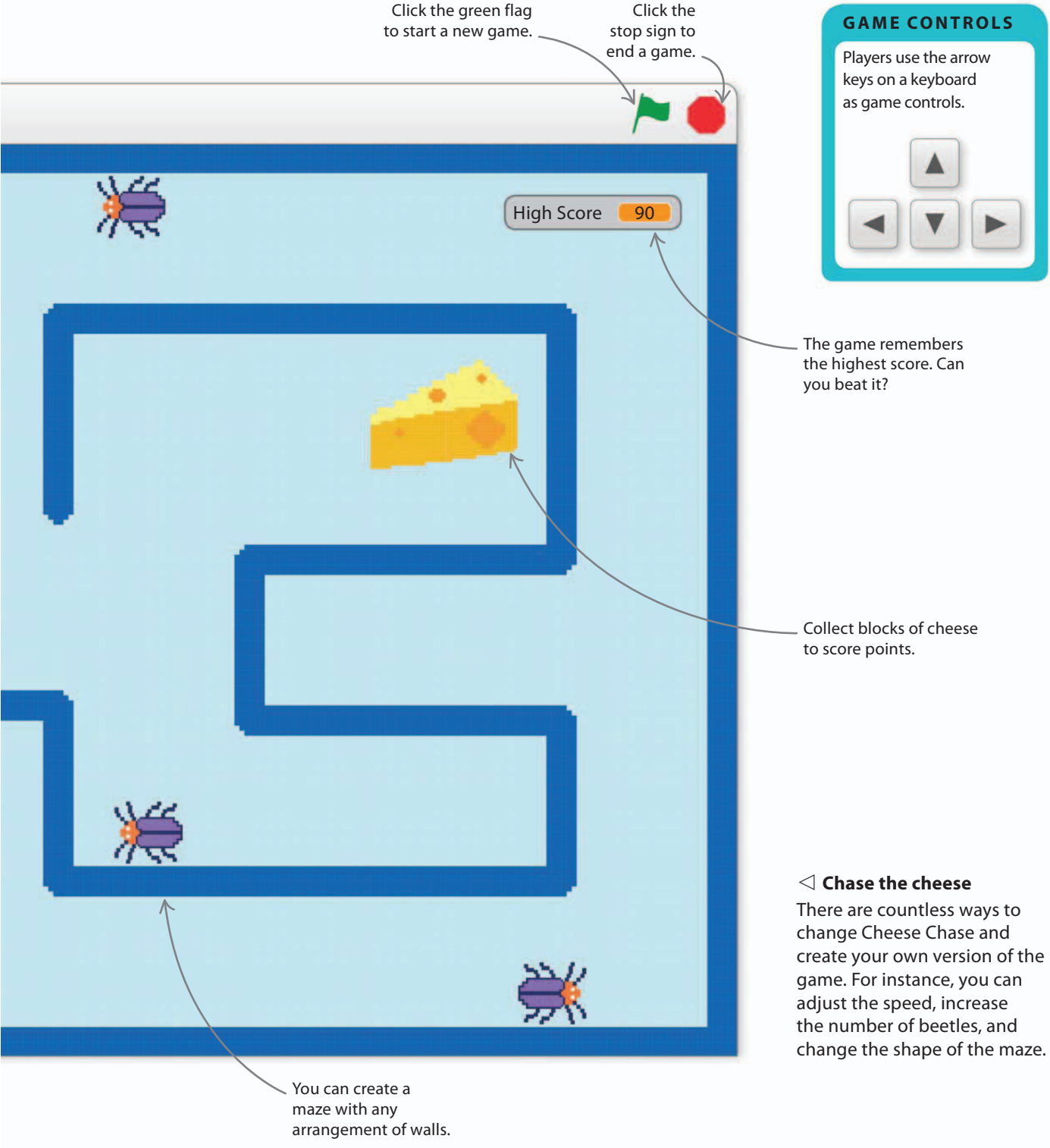
Mimi the mouse is hungry and stuck in a maze. Help her find the cheese but avoid the evil beetles. And watch out for ghosts—the maze is haunted!

◁ **Mimi**
You play the game as the mouse. Use the arrow keys on your keyboard to make her run up, down, left, or right.

◁ **Beetles**
Beetles scuttle along the edges and make random turns when they hit a wall.

◁ **Ghosts**
Ghosts can float through walls. They can appear anywhere without warning and then disappear.





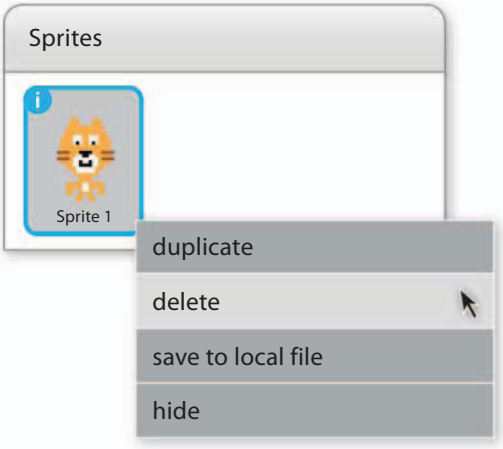
◁ **Chase the cheese**

There are countless ways to change Cheese Chase and create your own version of the game. For instance, you can adjust the speed, increase the number of beetles, and change the shape of the maze.

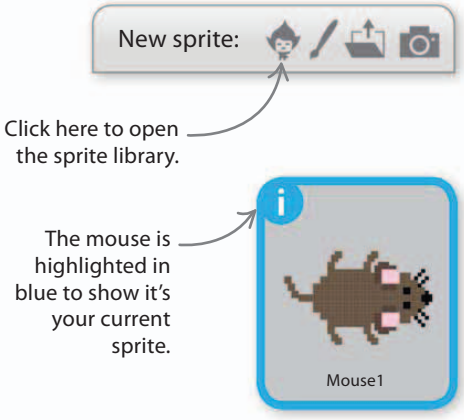
Keyboard control

Many games let the player use the keyboard to control the action. In Cheese Chase, the player uses the arrow keys on the keyboard to move Mimi the mouse around the stage. Start by creating a keyboard control script for Mimi.

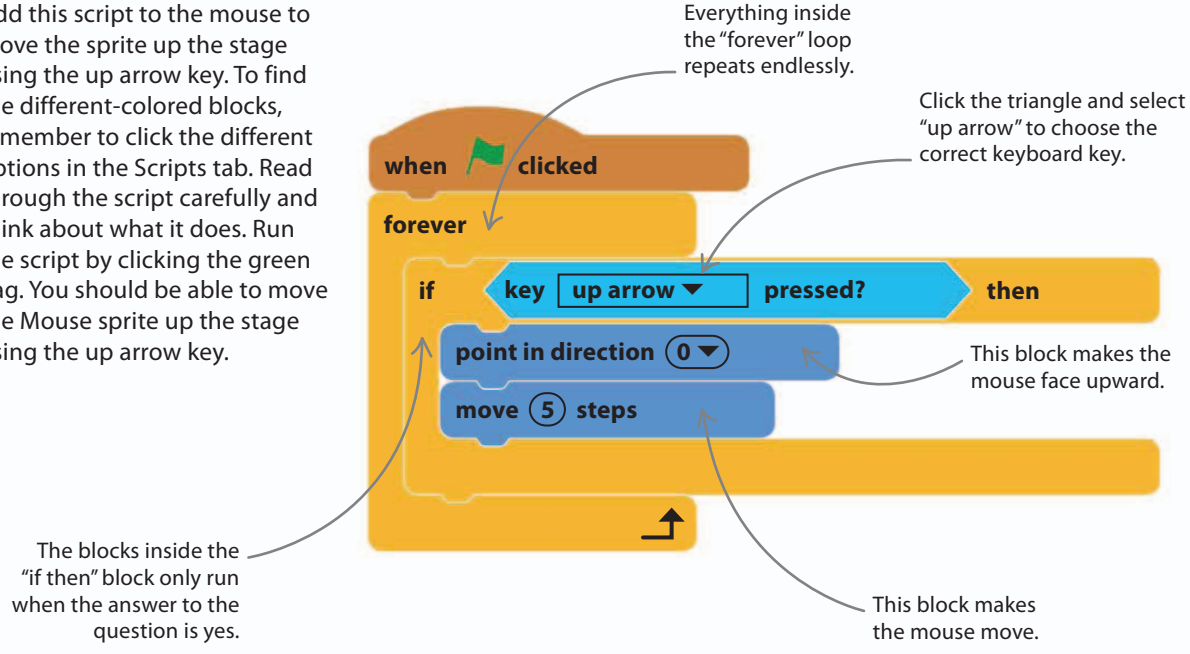
1 Start Scratch and choose "New Project". Delete the cat by right-clicking and selecting "delete". If you use a Mac computer, instead of right-clicking you can hold down the control key and click.



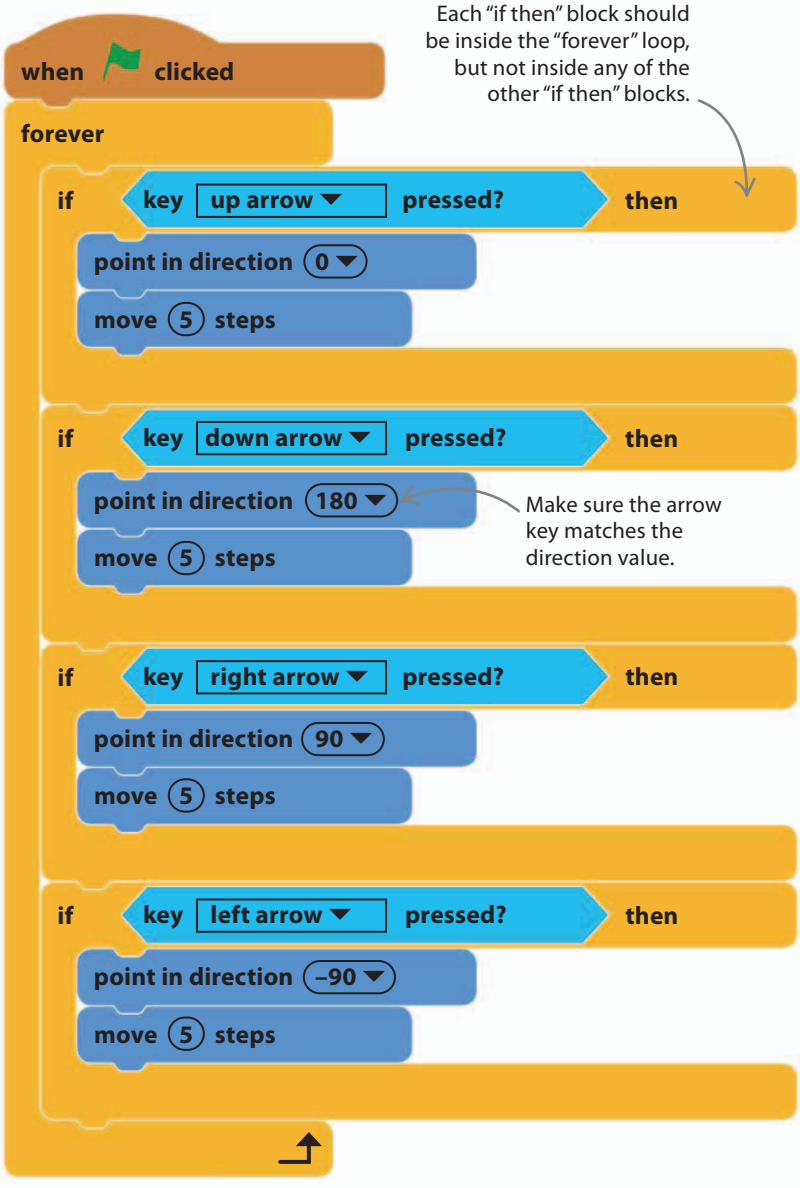
2 Click the "New sprite" symbol and look through the sprite library for Mouse1. Click "OK". The mouse should now be on the stage and in the sprites list.



3 Add this script to the mouse to move the sprite up the stage using the up arrow key. To find the different-colored blocks, remember to click the different options in the Scripts tab. Read through the script carefully and think about what it does. Run the script by clicking the green flag. You should be able to move the Mouse sprite up the stage using the up arrow key.



4 To make the other arrow keys work, add three more "if then" blocks like the first one, but choose a different arrow key and direction for each one. To move right, select the right arrow key and set the direction to 90. For down, set it to 180. For left, set it to –90. Read through the finished script to make sure you understand it.



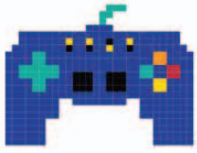
5 Now click the green flag to run the script. You should be able to move the mouse in all directions around the stage using the arrow keys. If it's not working, go back and check all the steps.

GAME DESIGN

Controllers

In Cheese Chase, we use the arrow keys to control the game, and in Star Hunter we used the mouse. Other computer games use very different types of controller.

▷ **Console controller**

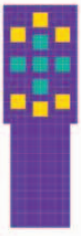


Console controllers usually have two small joysticks controlled with your thumbs, along with a range of other buttons. They are ideal for complex games that need a lot of different controls.

▷ **Dance mats**

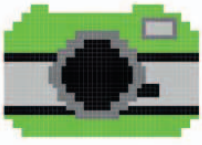
You control the game by stepping on giant keys. Dance mats are good for games involving physical activity, but they don't give fine control.

▷ **Motion sensor**



These controllers detect movement, which makes them ideal for sports games where you swing your arms to use a racquet or bat, for example.

▷ **Camera**

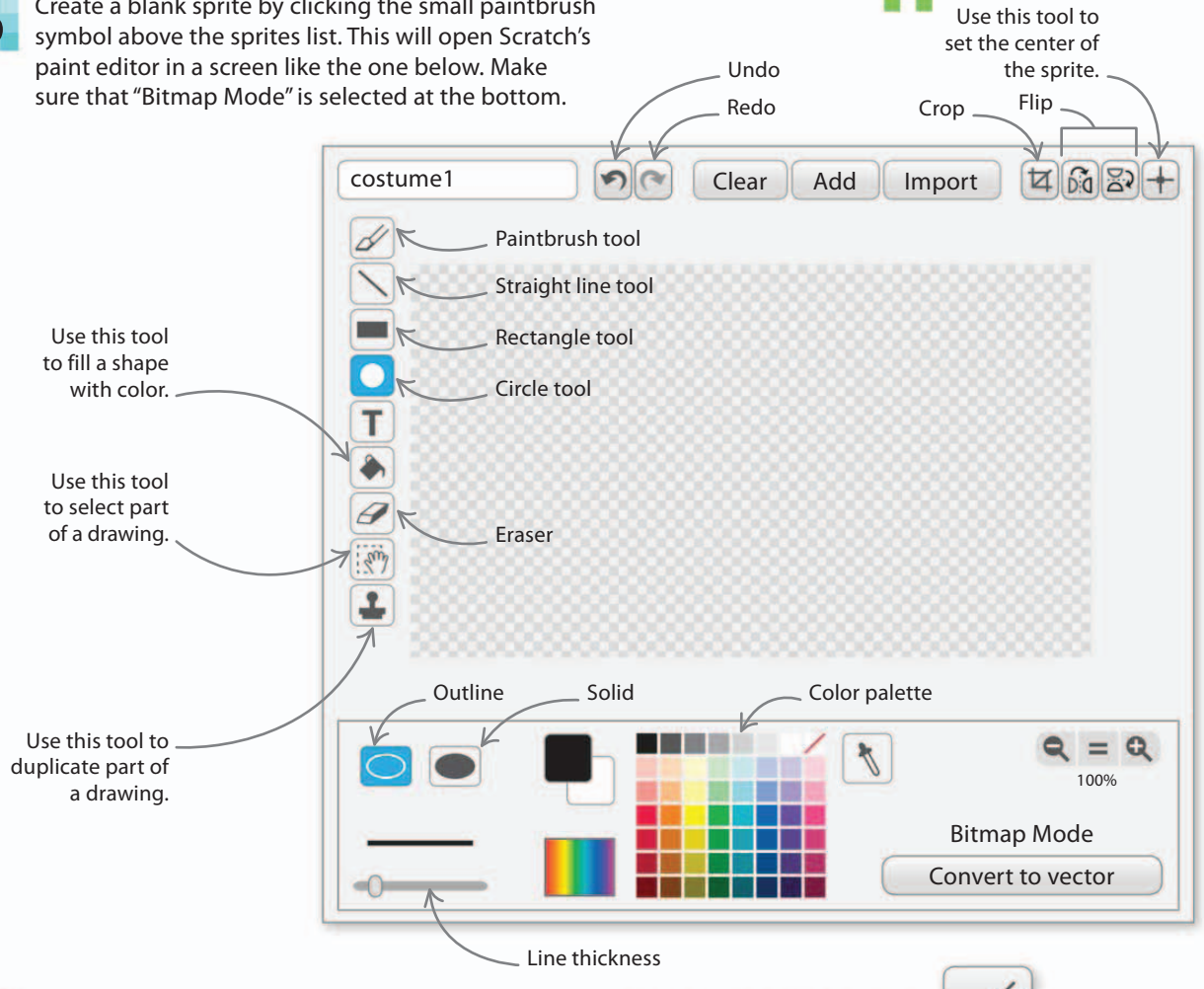


Special cameras in some game consoles allow the player to use body movements to control the game.

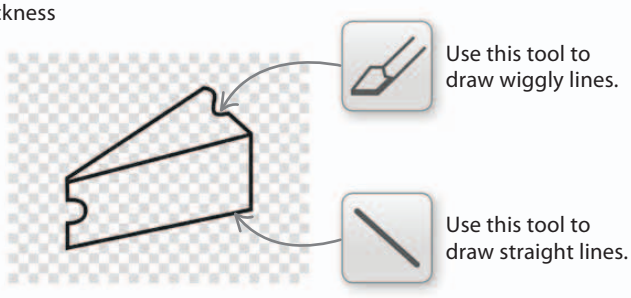
Using the paint editor

Cheese Chase now has its mouse heroine and she's hungry, but there's no cheese yet for her to chase. The sprite library in Scratch doesn't include a picture of cheese, so you'll need to make one yourself. You can do this with Scratch's paint editor.

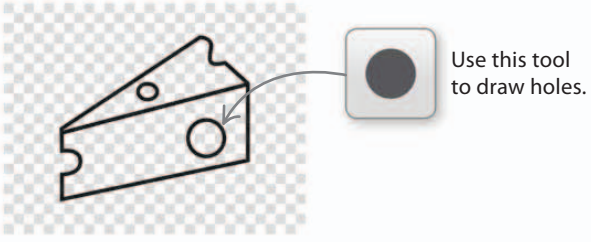
6 Create a blank sprite by clicking the small paintbrush symbol above the sprites list. This will open Scratch's paint editor in a screen like the one below. Make sure that "Bitmap Mode" is selected at the bottom.



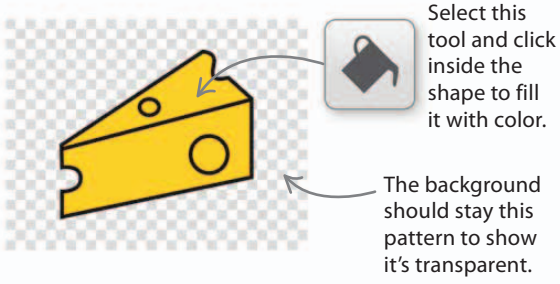
7 Now draw the cheese. Use the paintbrush tool and choose black from the color palette at the bottom of the screen. Draw the outline of the cheese. If you want perfectly straight lines, use the line tool. Your cheese drawing might be too big at first, but you can make it smaller later.



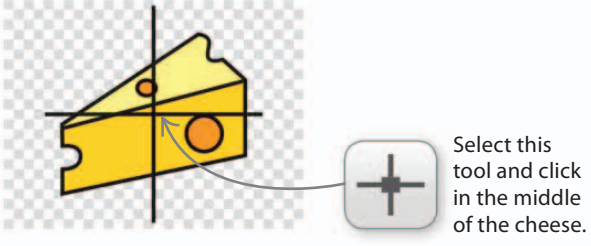
8 If you like, use the circle tool to draw holes in the cheese. Make the circle an outline rather than a solid circle by choosing the outline option at the bottom.



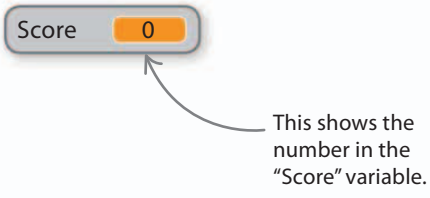
9 To add color, choose yellow and use the fill tool to fill in the cheese. If your color spills out and fills the whole background, click on the "undo" button. Make sure your lines don't have any gaps, then try again.



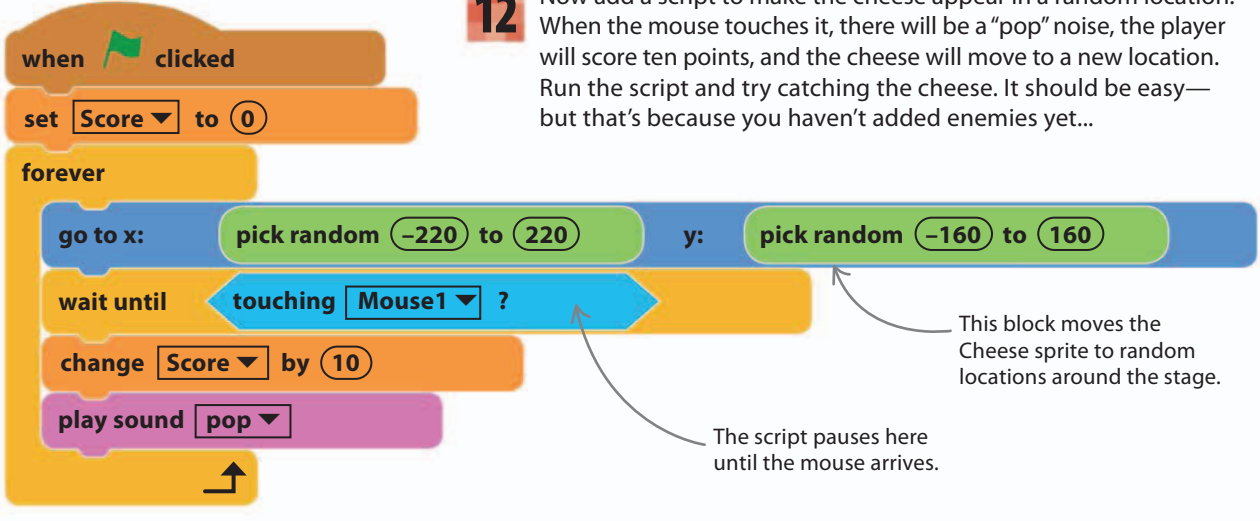
10 Now set the center of your cheese. Click the "Set costume center" tool in the top right and then click the middle of the cheese. The cheese is now ready to be added to the game.



11 To keep score, we need to create a variable called "Score". Choose Data in the blocks palette and click on "Make a Variable". Type the word "Score" in the pop-up box. The score counter will now appear on the stage.

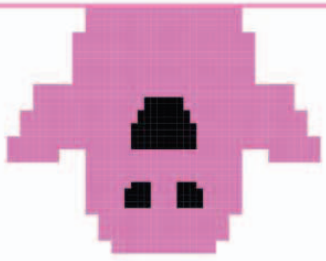


12 Now add a script to make the cheese appear in a random location. When the mouse touches it, there will be a "pop" noise, the player will score ten points, and the cheese will move to a new location. Run the script and try catching the cheese. It should be easy—but that's because you haven't added enemies yet...

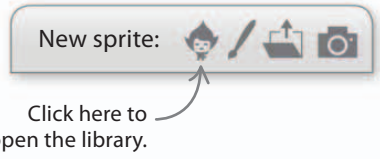


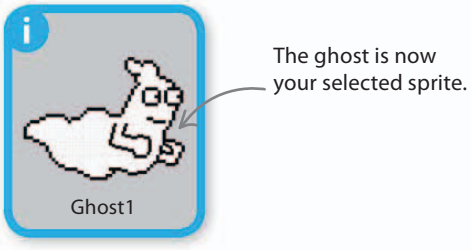
Getting spooky

Adding our first enemy to the project will make Cheese Chase into a proper game. A ghost is a good first enemy for this game because it can float through walls, so you won't need to change the ghost's script when we add the maze.

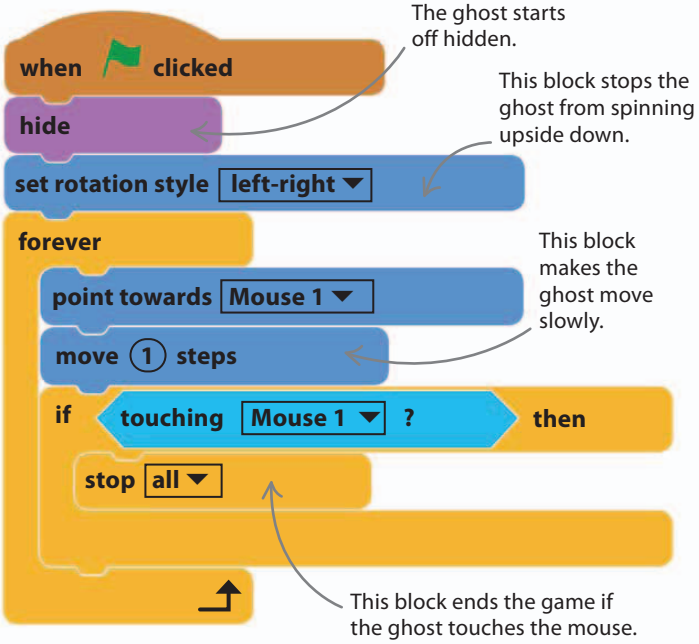


13 Click the "New sprite" symbol and select a ghost sprite from the sprite library. Click "OK" to add it to the project.



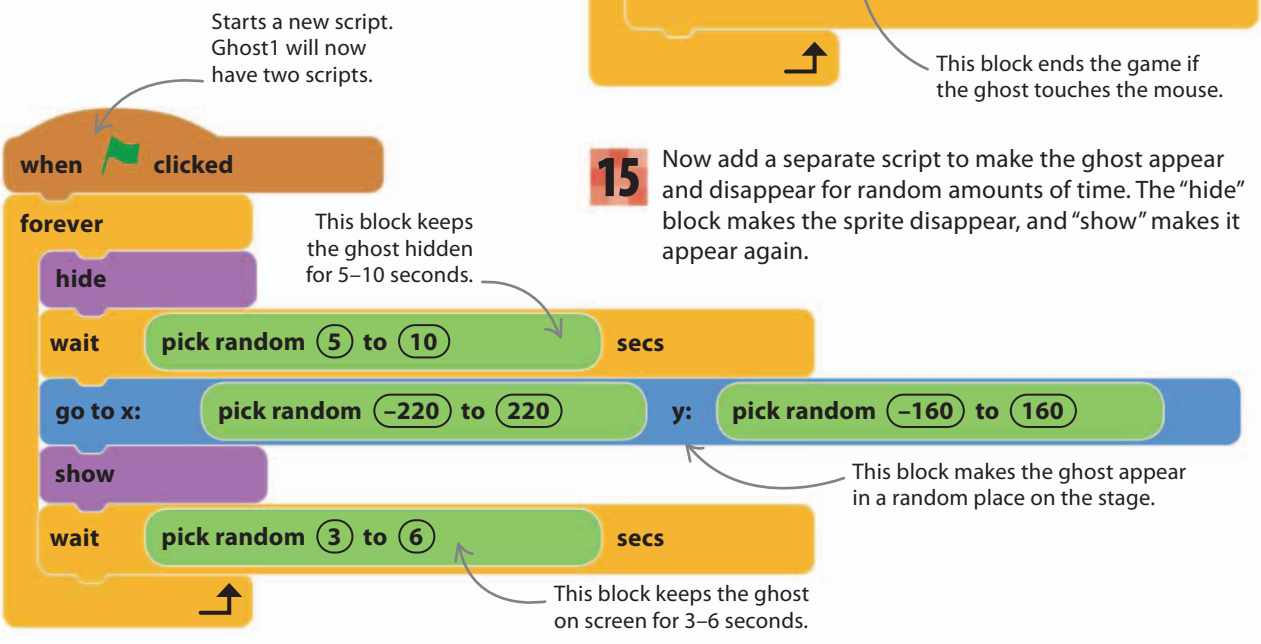


14 Add the following script to the ghost to make it chase the mouse. If it touches the mouse, the game will end. You might recognize most of this code from Star Hunter.

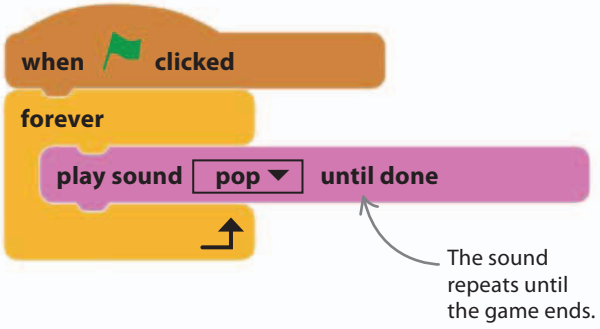


Starts a new script. Ghost1 will now have two scripts.

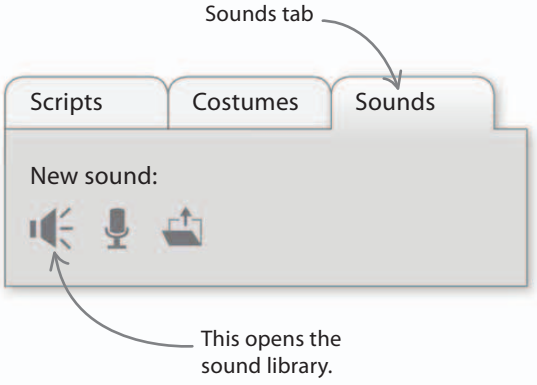
15 Now add a separate script to make the ghost appear and disappear for random amounts of time. The "hide" block makes the sprite disappear, and "show" makes it appear again.



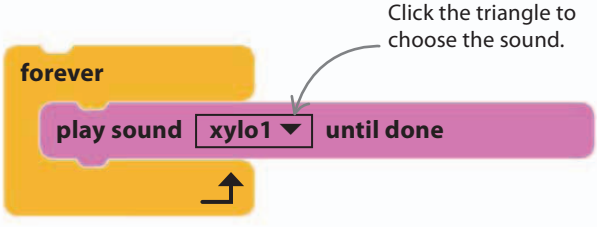
16 Next, add music to the game. We usually add music to the stage rather than a sprite. Click the stage area on the left of the sprites list to highlight it in blue. Click the Scripts tab and add the following script to play a sound over and over. Click "Sound" in the blocks palette to find the "play sound until done" block.



17 Now click the Sounds tab above the blocks palette. Click the speaker symbol to open the sound library. Select the category "Music Loops" on the left, then choose the music "xylo1" and click "OK". Repeat the process to load "dance celebrate" into the game too.



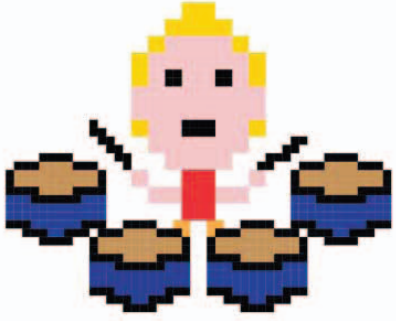
18 Return to the Scripts tab and change the selected sound from "pop" to "xylo1". Run the game and think about how it feels to play. Next try the sound "dance celebrate". Which one is better?

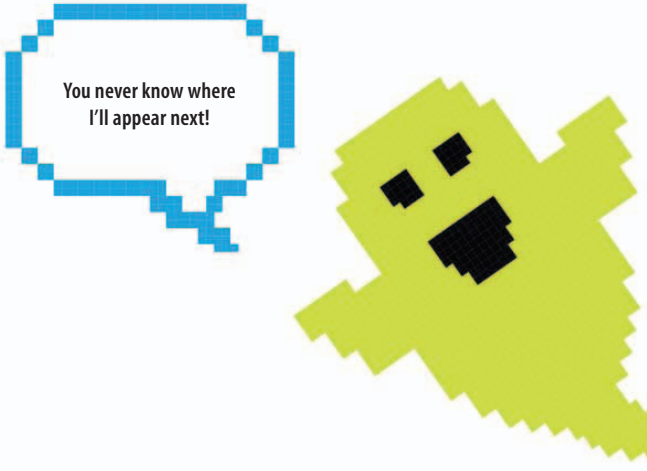


GAME DESIGN

Music in games

Watch a scary film with the sound off and it's not so scary anymore. Games are the same—the music sets the mood. A fast-paced game will use music with a driving beat to make you hurry. A spooky game should have haunting music to make you feel uneasy—happy, bouncy music would break the spell. A puzzle game might have echoing, eerie music to create a sense of mystery. Some games use music as a key part of the game play, such as those where the player has to dance or push buttons in time to the beat.

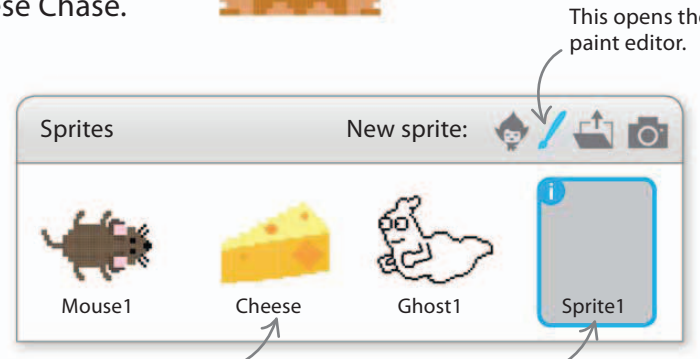




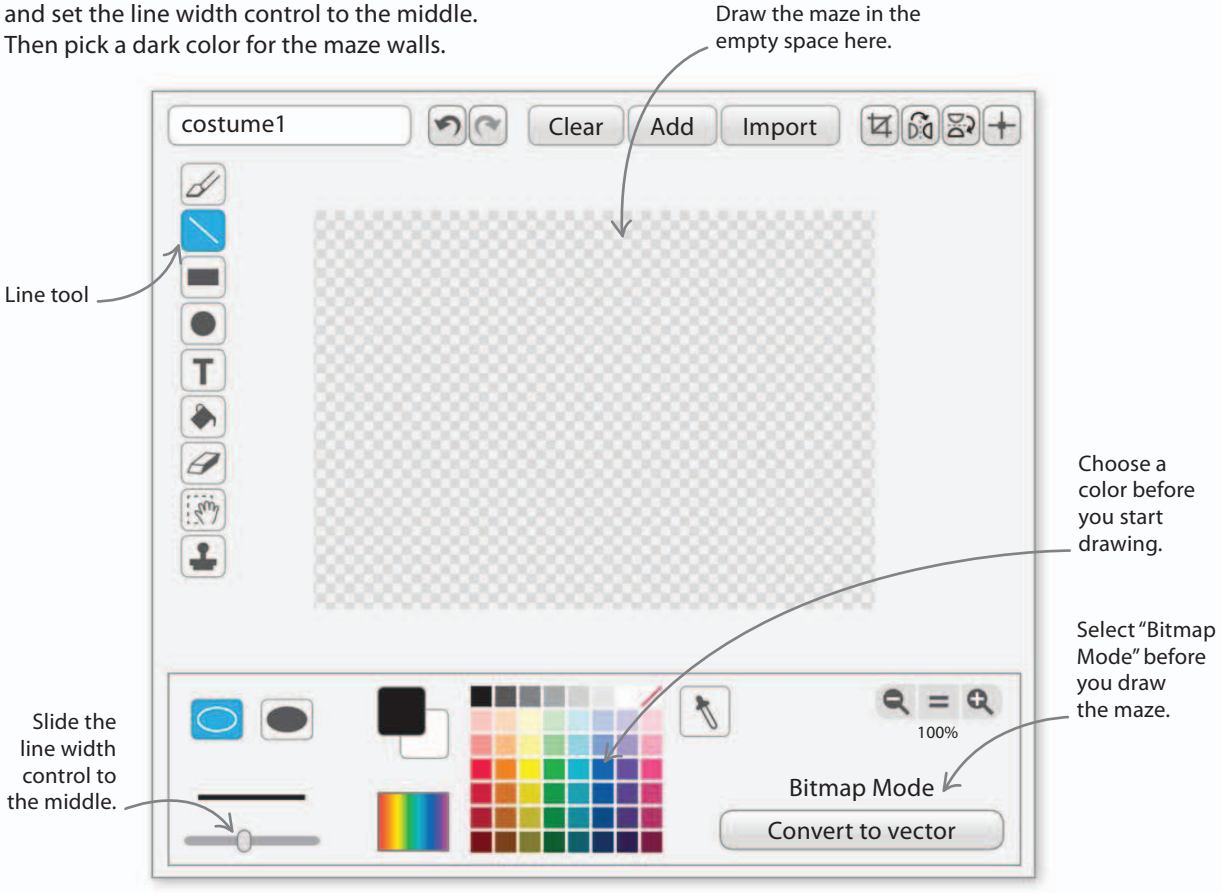
Making mazes

Mimi the mouse can run anywhere she likes on the stage. Put a stop to that by adding a maze. The maze will make it difficult for her to move from one place to another, adding an extra challenge to Cheese Chase.

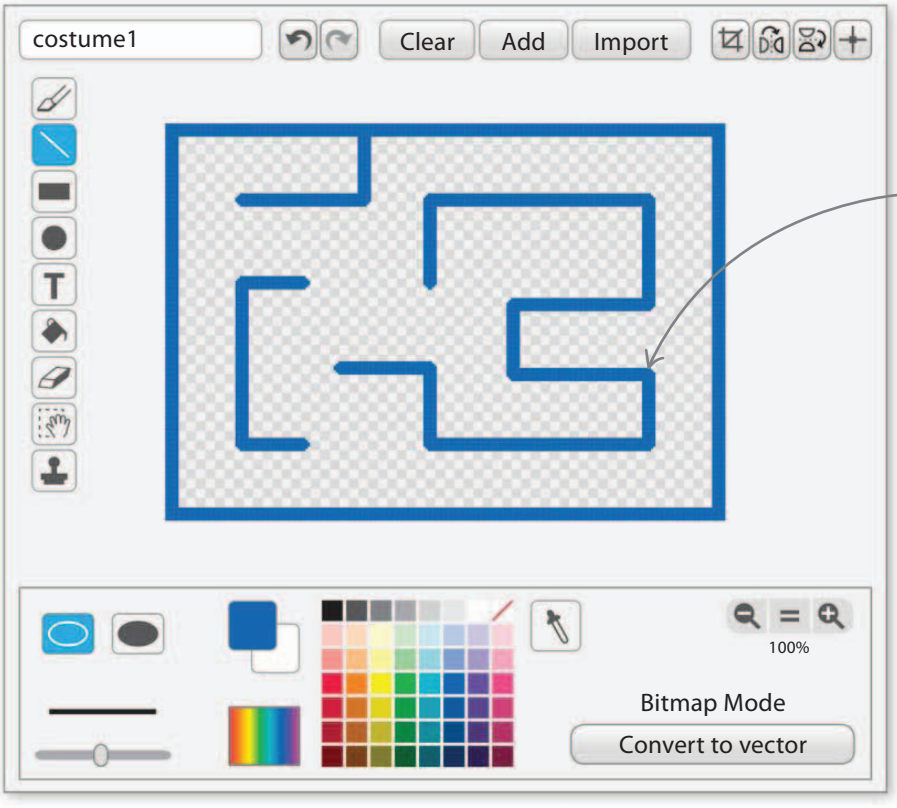
19 The maze will be a sprite, not a backdrop, because that makes it easier to detect when another sprite touches it. Draw it in Scratch's paint editor. Click on the paintbrush symbol in the sprites list, then click on the blue "i" and rename the sprite "Maze".



20 Now you can start using the paint editor. Make sure "Bitmap Mode" is selected in the bottom right. If not, click the "Convert to bitmap" button to change the mode. Choose the line tool and set the line width control to the middle. Then pick a dark color for the maze walls.

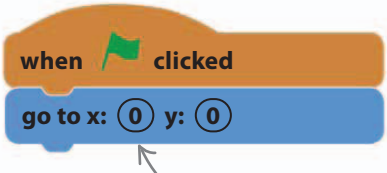


21 Now draw the maze. Start by drawing the outside of the maze at the outer edge of the checkered drawing area. Hold down the shift key on your keyboard to make sure lines are perfectly vertical or horizontal. Then add the inside walls.



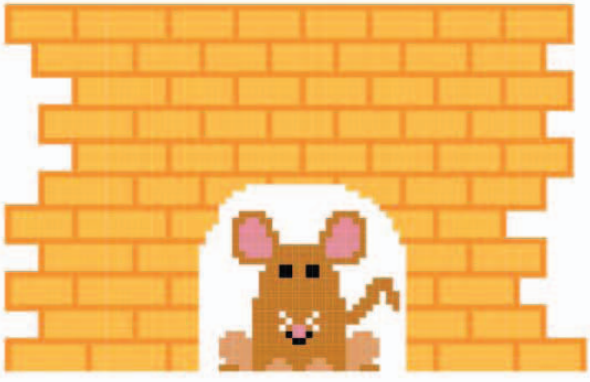
Make sure that the lines of the maze are perfectly straight.

22 Finally, we need to add a script to make sure the maze is always in the center of the stage so it's fully visible. With the Maze sprite selected, click on the Scripts tab and add the following script.

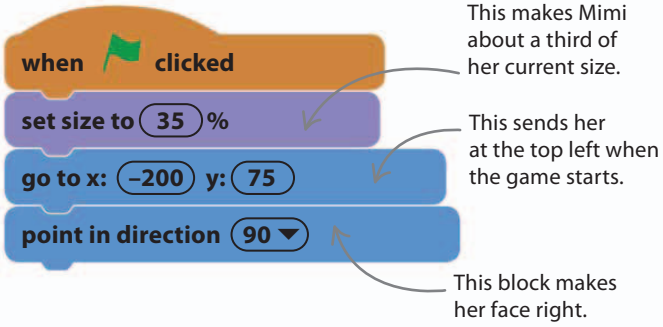


At the center of the stage, x is 0 and y is 0.

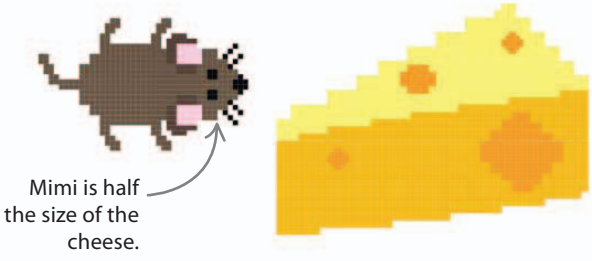
23 Run the project. You'll find that Mimi can run through walls, but don't worry because we'll fix that later.



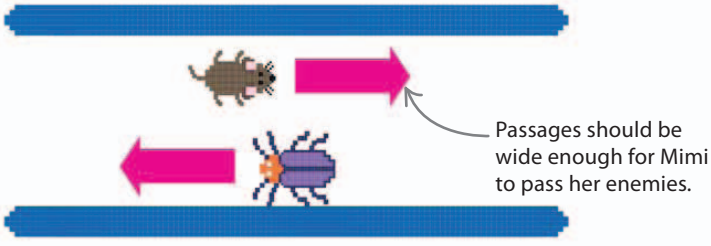
24 Mimi, the ghost, and the cheese are all too big for the maze, so we need to shrink them. Add the following blocks at the beginning of Mimi's script, before the "forever" block, and fill in the numbers below.



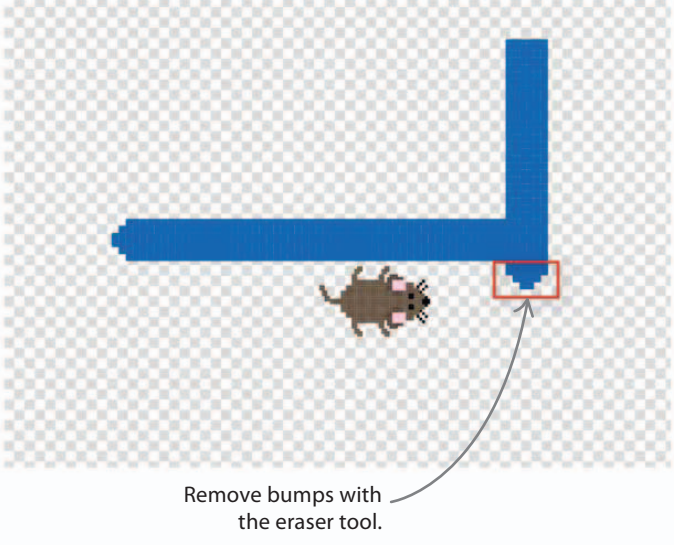
25 Now add a purple "set size to" block to the ghost's main script. Set the size to 35 percent. Add a "set size to" block to the Cheese sprite too, and adjust the percentage until the cheese is about twice the size of Mimi.



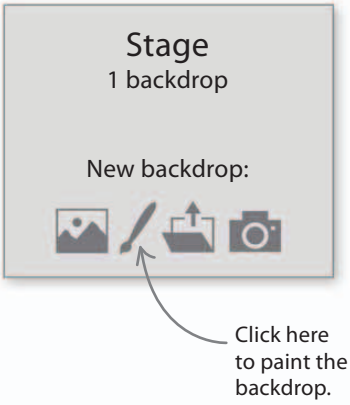
26 You might need to fine-tune your Maze costume to make sure Mimi can fit through all the passages with enough room to pass her enemies (which we're going to add later). To alter the maze, select the Maze sprite and click the Costumes tab. Use the eraser tool to remove walls or the selection tool to move them.



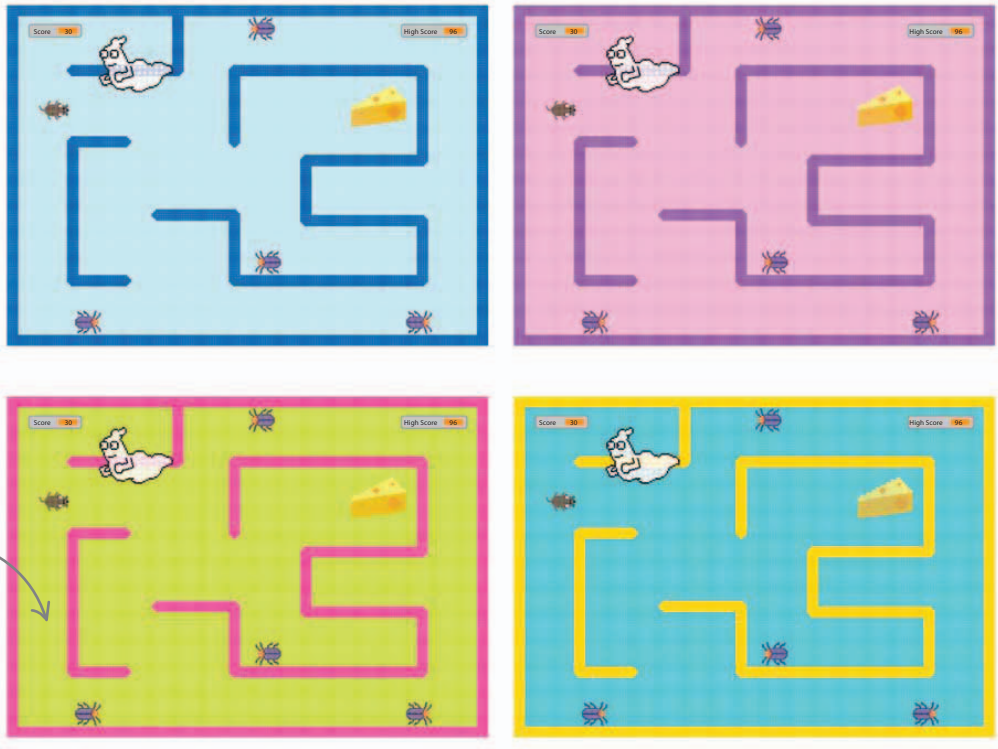
27 If you use the eraser, be careful not to leave any flecks of paint behind because Mimi will stop if she hits them. Check the corners of the maze for bumps that Mimi might get stuck on and remove them.



28 Add a background color to the game by painting a backdrop, not the Maze sprite. At the bottom left of the screen, click the paintbrush symbol in the stage info area. This opens the paint editor. Make sure "Bitmap Mode" is selected at the bottom.



29 Choose a color, select the fill tool, and then click on the backdrop to fill it with color.



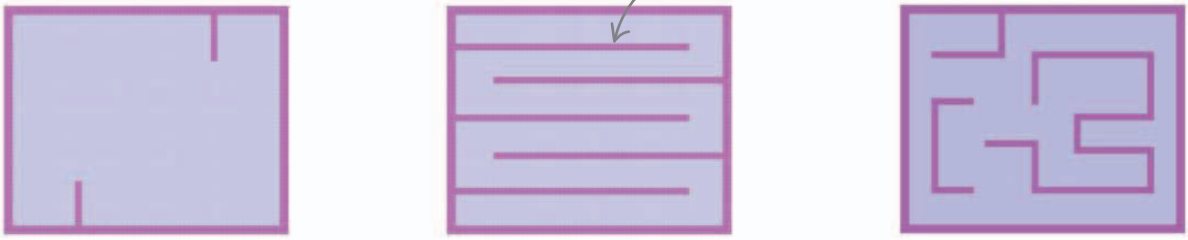
Try different colors to see which one looks best in the maze.

GAME DESIGN

Space in games

How the obstacles in a game are laid out has a big effect on how you play. A maze is the perfect obstacle to demonstrate this.

Walls restrict movement.



△ **Open space**
The player can move in any direction most of the time. A game like this needs fast-moving enemies or lots of enemies to make it challenging.

△ **Closed-in space**
The player is forced to move in a very limited way. Just one enemy patrolling the corridors of this maze would make life hard. The player has to think ahead to avoid getting trapped.

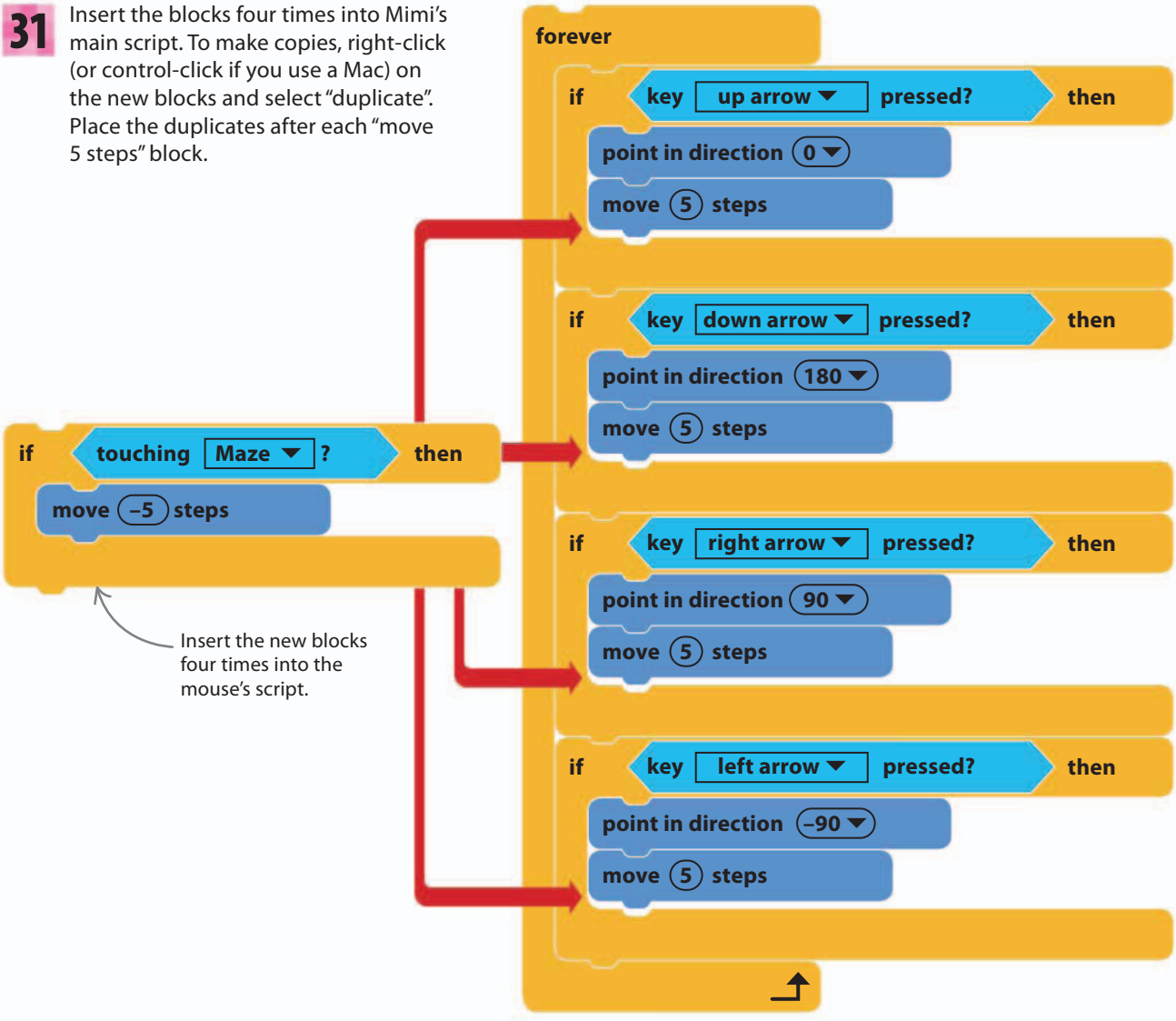
△ **Balanced space**
This is what the maze in Cheese Chase is designed to be. It limits the player's movement enough to make the game interesting, but allows some freedom.

Mousetrap

Mimi can currently run straight through the walls of the maze like a ghost, but we want her to stay trapped inside the passages. Time to change her script.

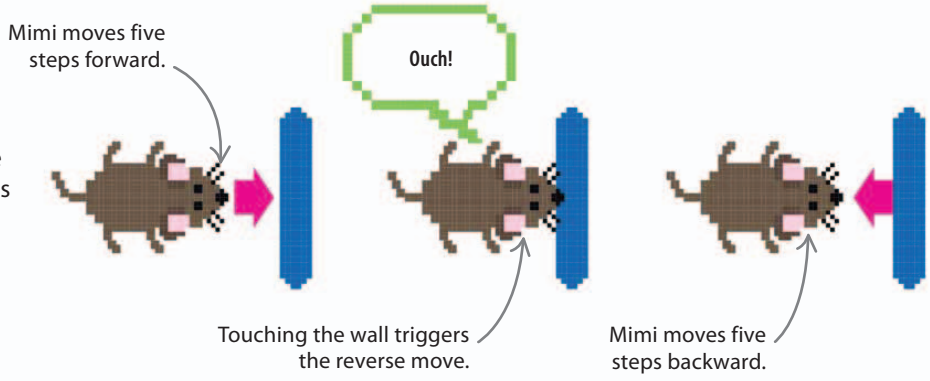
30 Select Mimi and drag the following blocks to an empty part of the scripts area. This set of blocks will make Mimi reverse if she runs into a wall.

31 Insert the blocks four times into Mimi's main script. To make copies, right-click (or control-click if you use a Mac) on the new blocks and select "duplicate". Place the duplicates after each "move 5 steps" block.

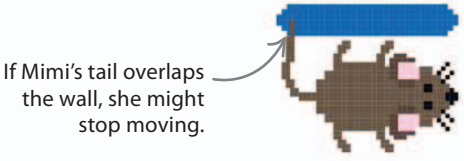


▷ How does it work?

You might wonder why Mimi has to move five steps backward. The reason is that she normally moves forward five steps at a time. The backward move reverses the forward one, making her stand still. This happens so quickly that you don't see her reverse.

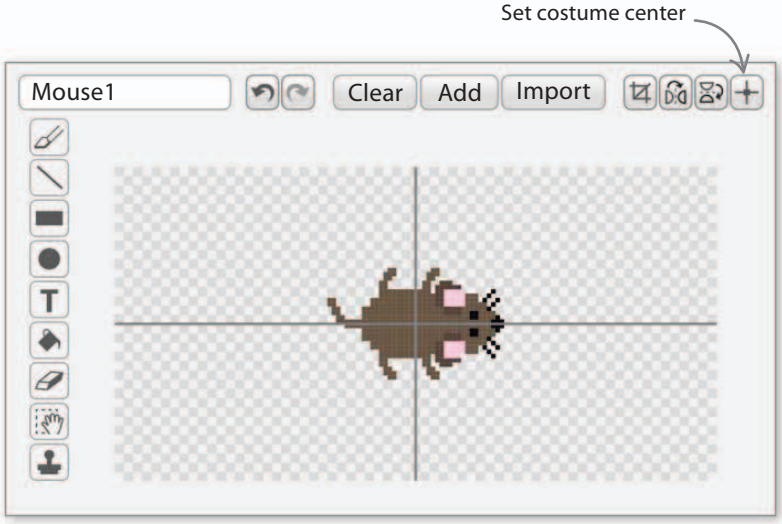


32 If Mimi's tail or paws touch a wall when she turns around, she can get stuck. We can fix this bug by making some changes to Mimi's costume in the paint editor.



33 Select Mouse2 in the sprites list and click the Costumes tab above the blocks palette. Choose "Convert to bitmap" at the bottom, and then use the eraser tool to trim Mimi's tail.

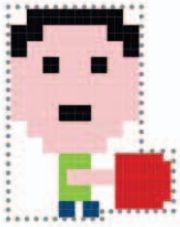
34 There's another problem that we can fix. Every sprite has a center point, but if this isn't in the exact center, the mouse will wobble when its direction changes and might overlap a wall and get stuck. Choose the "Set costume center" tool and then click in the exact middle of Mimi to correct her center point.



EXPERT TIPS

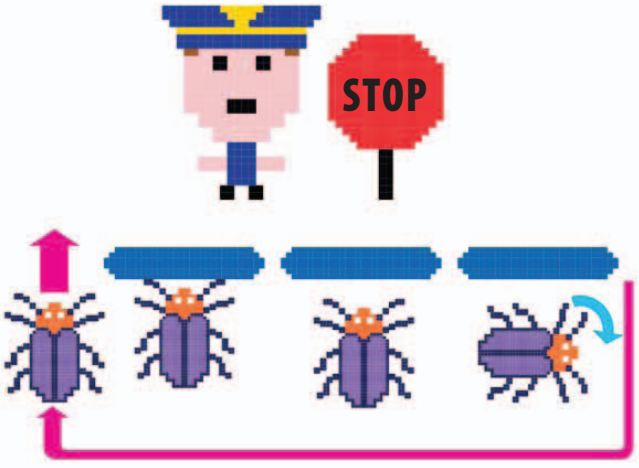
Bounding boxes

One of the big challenges that game programmers face is detecting when sprites with complicated shapes collide. Even in simple 2D games, collision detection can cause problems, such as sprites getting stuck or solid objects merging. A common solution is to use "bounding boxes"—invisible rectangles or circles that surround the sprite. When these simple shapes intersect, a collision is detected. In 3D games, spheres or 3D boxes can do the same job.



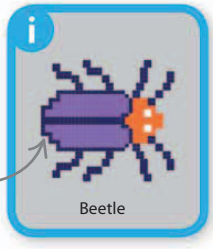
Beetle mania

Now for Mimi's main enemies: a small army of evil beetles that scurry around inside the maze. If she bumps into one, the game ends.



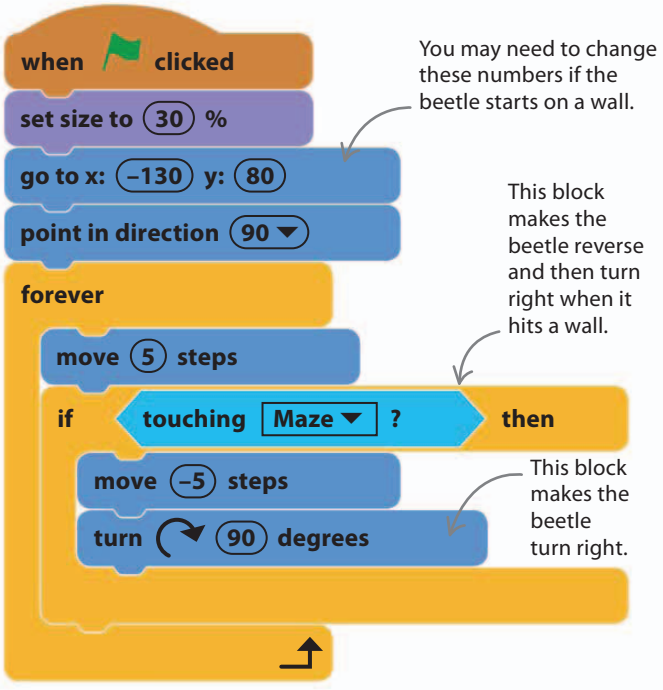
35 To make the beetles move automatically, you need to create a sequence of steps for them to follow. Programmers call this an algorithm. Our algorithm will tell each beetle to move forward until it hits a wall. Then it will stop, turn, and move forward again.

36 Click the "New sprite" symbol and choose the Beetle sprite from the library.

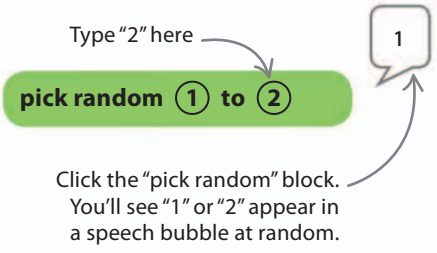


The beetle is now your selected sprite.

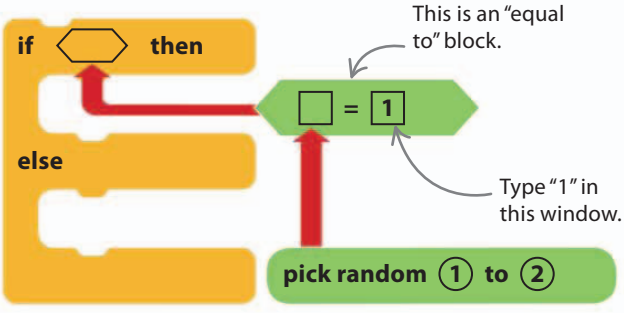
37 Add the following script to set the beetle's size, location, and direction. It uses a "forever" loop to move the beetle, and an "if then" block to make it stop and turn right whenever it hits a wall.



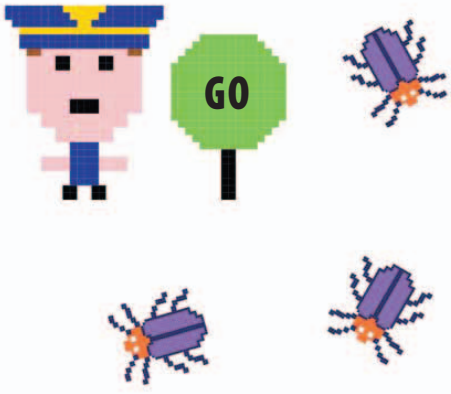
38 Run the script. You might notice a glitch: the beetle always turns right and ends up going around in loops. We need to change the script so that the beetle turns left or right at random. To make a random choice, use a "pick random" block. Drag it to an empty part of the scripts area and set the second number to 2.



39 Now drag the "pick random" block into the first window of an "equal to" block. Then drag the "equal to" block into an "if then else" block.



40 Add two "turn 90 degrees" blocks to make the beetle turn left or right. Read through the script carefully and see if you can figure out how it works.




```
if pick random 1 to 2 = 1 then
    turn 90 degrees
else
    turn 90 degrees
```

41 Remove the "turn 90 degrees" block from the beetle's original script and put the "if then else" block in its place, as below. Run the project and watch what happens. Check there's enough room for Mimi to squeeze past the beetle. If not, adjust the maze in the paint editor.

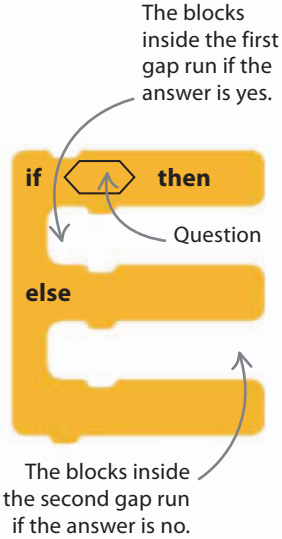
```
when clicked
set size to 30 %
go to x: -130 y: 80
point in direction 90
forever
    move 5 steps
    if touching Maze ? then
        move -5 steps
        if pick random 1 to 2 = 1 then
            turn 90 degrees
        else
            turn 90 degrees
```

The blocks inside the "if then" block run only when the beetle touches the maze.

EXPERT TIPS

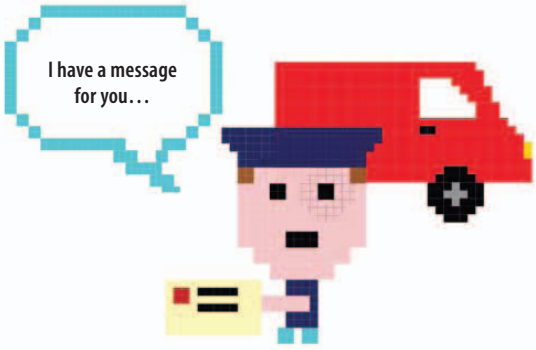
if then else

The "if then else" block is just like an "if then" but with an extra trick. A normal "if then" asks a question and runs the blocks inside only if the answer is yes. The "if then else" block can hold two groups of blocks: one to run if the answer is yes, and another if the answer is no. The words "if", "then", and "else" are used in nearly all computer languages to make decisions between two options.

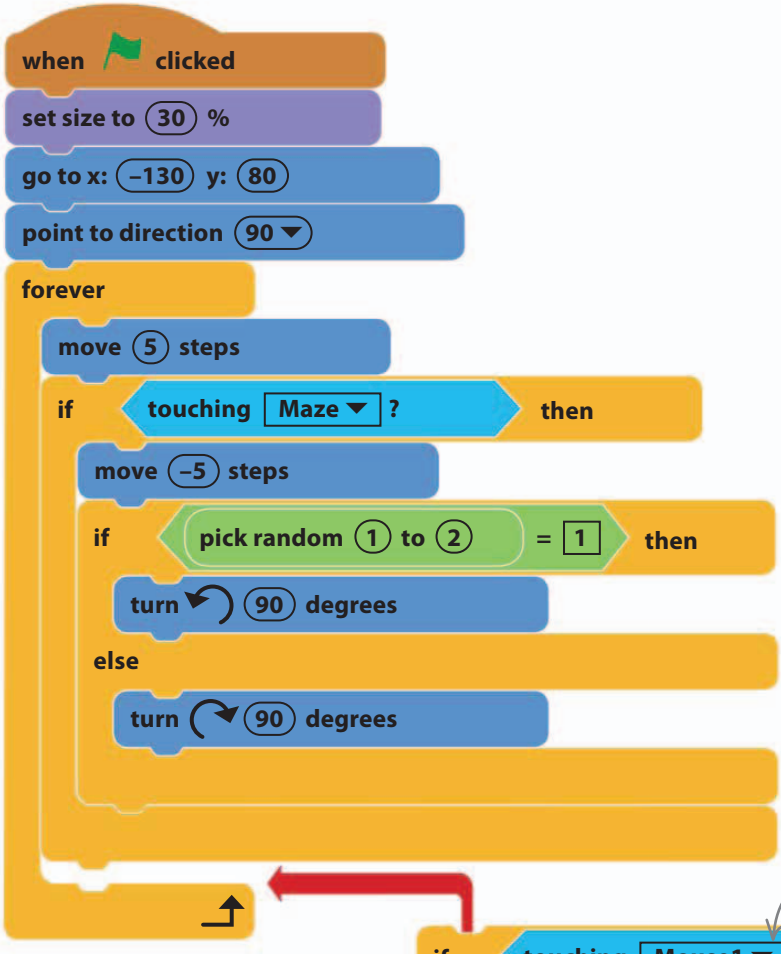


Sending messages

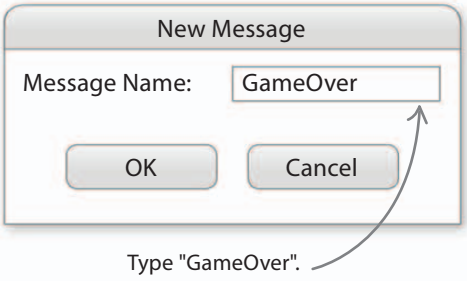
The next step is to make the beetle end the game if Mimi bumps into it. Instead of using another "touching" block in Mimi's script, you can use a message. Scratch lets you send messages between sprites to trigger scripts. The beetle will send a message to Mimi that stops her script.



42 Add the "if then" blocks shown below to the beetle's script. The new blocks check whether the beetle is touching Mimi and, if it is, send a message. Select "Mouse1" in the "touching" block.



43 Now give the message a name. Select "message1" in the "broadcast" block, choose "new message", and type "GameOver".

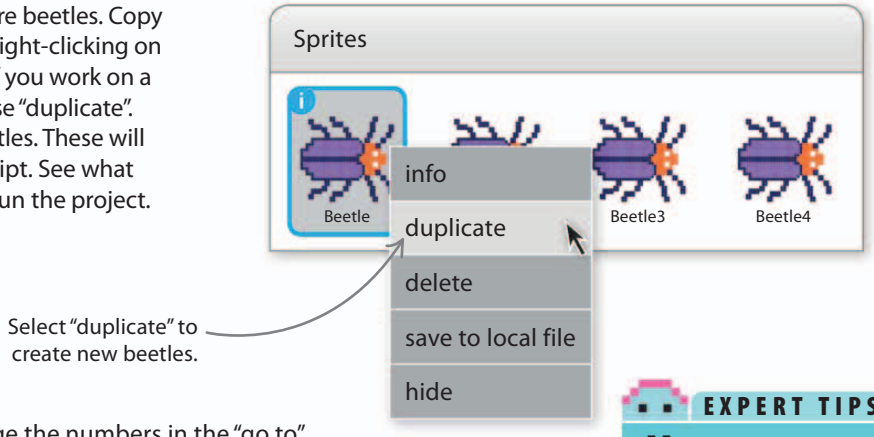


Select "Mouse1".

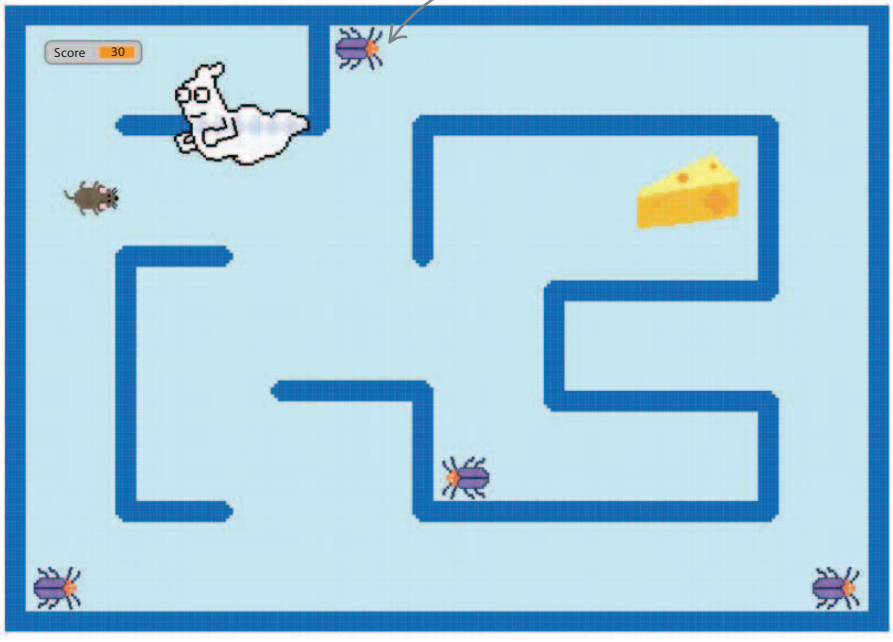
This block is found under Events. It sends a message when the beetle hits Mimi.

44 Now add an extra script to Mimi to receive the message. Drag the following blocks to an empty part of her scripts area. Try the game out. Mimi should stop moving when she touches the beetle, but the beetle will continue to move. Later we'll use a message to show a "GAME OVER!" sign as well.

45 The game needs more beetles. Copy the Beetle sprite by right-clicking on it (use control-click if you work on a Mac) and then choose "duplicate". Make three new beetles. These will all have the same script. See what happens when you run the project.



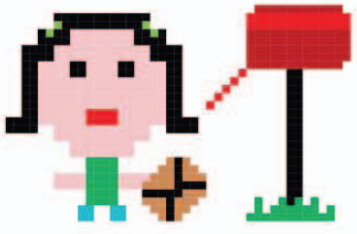
46 You'll need to change the numbers in the "go to" blocks for each new beetle so they don't all start in the same place. Starting in different corners works quite well. Experiment!



EXPERT TIPS

Messages

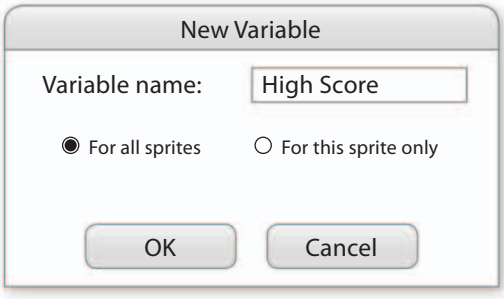
Messages provide a neat way of making sprites react to each other. We could have made the mouse check if it's touching a beetle, but that would mean adding "if then" and "touching" blocks to Mimi's script for all four beetles. By using messages, we can add more enemies without changing Mimi's code.



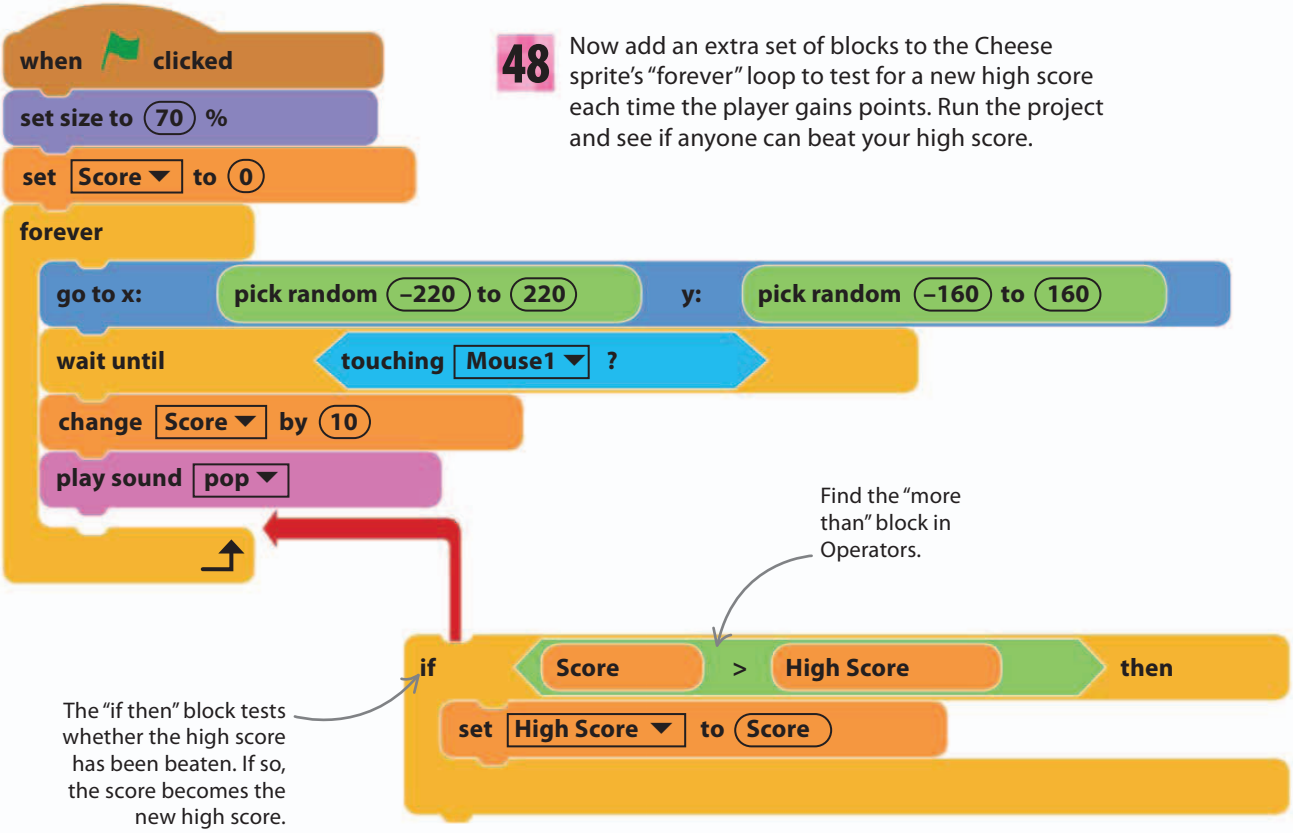
High score

You can make a game more fun by adding a high score for players to beat. We create this in the same way as the score tracker: by making a variable and displaying it on the stage.

47 Select Data in the blocks palette. Click "Make a Variable" and create a new variable called "High Score". A new block will appear, and the high score counter will appear on the stage. Drag it wherever you like.



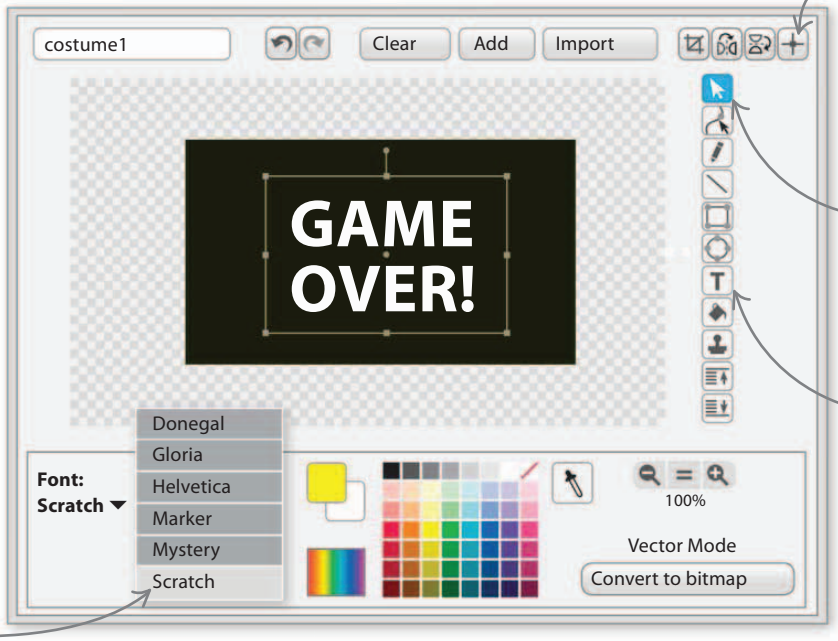
48 Now add an extra set of blocks to the Cheese sprite's "forever" loop to test for a new high score each time the player gains points. Run the project and see if anyone can beat your high score.



Game over!

At the moment, the only signal the game has ended is that the mouse stops moving. You can add a finishing touch to any game by displaying a large, bold "GAME OVER!" sign. To do this you need to create a "Game Over!" sprite and use the "GameOver" message to make it appear.

49 Click the paintbrush symbol in the sprites list to create a new sprite with the paint editor. Using "Bitmap Mode", draw a rectangle and fill it with a dark color. Now switch to "Vector Mode". Choose a bright color and use the text tool to type "GAME OVER!" in the rectangle. Change the font to "Scratch" and use the selection tool to make the text large.



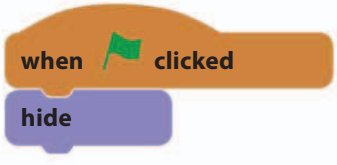
Don't forget to check the sprite's center with the set center tool.

Use the selection tool to enlarge the text.

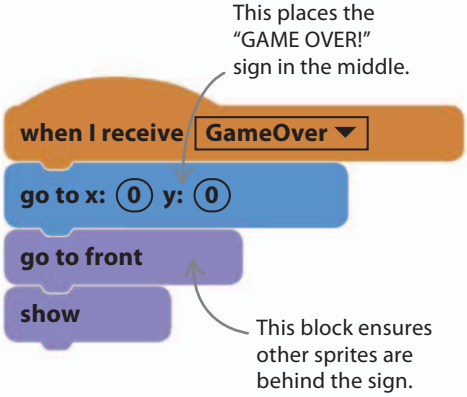
To change the font, highlight the text first.

Change the font to Scratch.

50 You don't want the "GAME OVER!" sign to show until the game is really over, so let's hide it with a script. Switch to the Scripts tab and add these blocks.



51 Now add a script to make the sprite appear when the game ends. You can use the same message that stops Mimi to trigger this script.



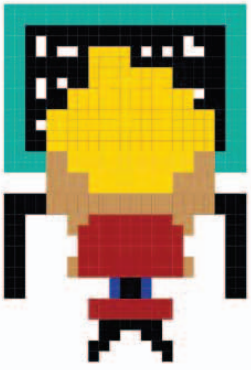
This places the "GAME OVER!" sign in the middle.

This block ensures other sprites are behind the sign.

52 Run the game. You should now see the "GAME OVER!" sign when you get caught by a beetle. To make the sign work with the ghost too, replace its "stop all" block with a "broadcast GameOver" block.

Hacks and tweaks

Take Cheese Chase to the next level by tweaking the rules of the game and the way the sprites behave. You can also experiment with big changes that turn Cheese Chase into a totally different kind of game.



◁ **Play on**

You need to play the game a lot to find out what works and what can be improved. Get other people to play. You can adjust many properties of the game until you get the right configuration: a game where the abilities of the player and enemies are well balanced.

△ **Add sounds**

Jazz up the game with some sound effects using the "play sounds" block when the ghost appears, when the game ends, or when you get a high score. There are lots of sounds in Scratch's sound library that you can experiment with.

▷ **Tweak timings**

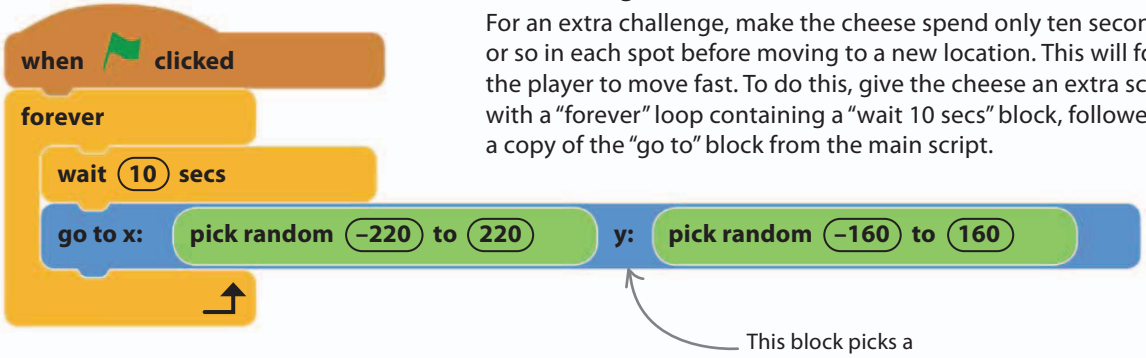
You might find Cheese Chase harder than Star Hunter. To make it easier, you can make the beetles slower or make the ghost appear for a shorter time. You can also speed up Mimi. For variety, try making each beetle run at a different speed.

▷ **Rocket power**

Add a power boost that hides all the enemies for ten seconds when the mouse touches it. To do this, you would need to add a new sprite and a message to trigger a hide-wait-show script in each enemy.

▽ **Vanishing cheese**

For an extra challenge, make the cheese spend only ten seconds or so in each spot before moving to a new location. This will force the player to move fast. To do this, give the cheese an extra script with a "forever" loop containing a "wait 10 secs" block, followed by a copy of the "go to" block from the main script.



▷ Don't touch the walls

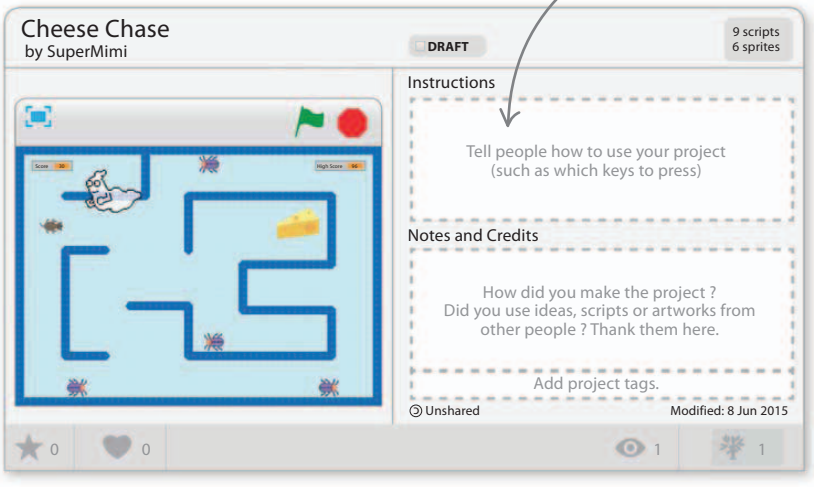
Make the game end if Mimi touches the walls of the maze. Add a script to the Maze sprite to send the message "GameOver" if she touches the maze. This makes the game much harder. To make it even harder, try switching the player's controls from the keyboard to the computer mouse. The game then becomes a test of a steady hand.

Adding instructions

Players like to see a game's instructions clearly before they start playing. Here are three ways of including instructions.

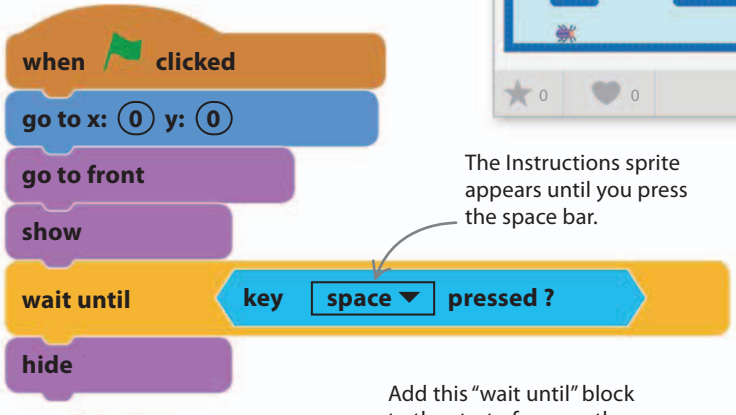
▽ Project page

The easiest way to include instructions is to simply type them in the instructions box on the project page. You need to log in to an online Scratch account to do this.



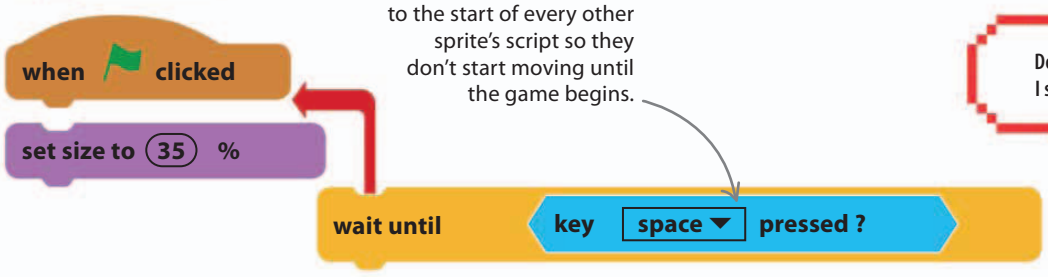
▽ Instructions sprite

You can use the paint editor to create an Instructions sprite in the same way that you created the Game Over sprite. Give it the following script to show the sprite at the start of the game and to hide it once the player presses the space bar.



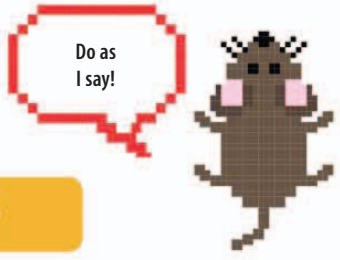
The Instructions sprite appears until you press the space bar.

Add this "wait until" block to the start of every other sprite's script so they don't start moving until the game begins.



▽ Speech bubbles

Make your game characters tell the player the instructions using speech bubbles. Add a "say" block to the start of Mimi's script to explain the game. Don't forget to add "wait" blocks to the enemies' scripts—otherwise there's a risk you'll lose before you start!



Circle Wars

How to build Circle Wars

Lightning reactions are essential in Circle Wars, a fast-paced game in which you hunt green circles while being chased by red ones. The game uses Scratch's clones feature, which can turn a single sprite into an army of sinister copies.

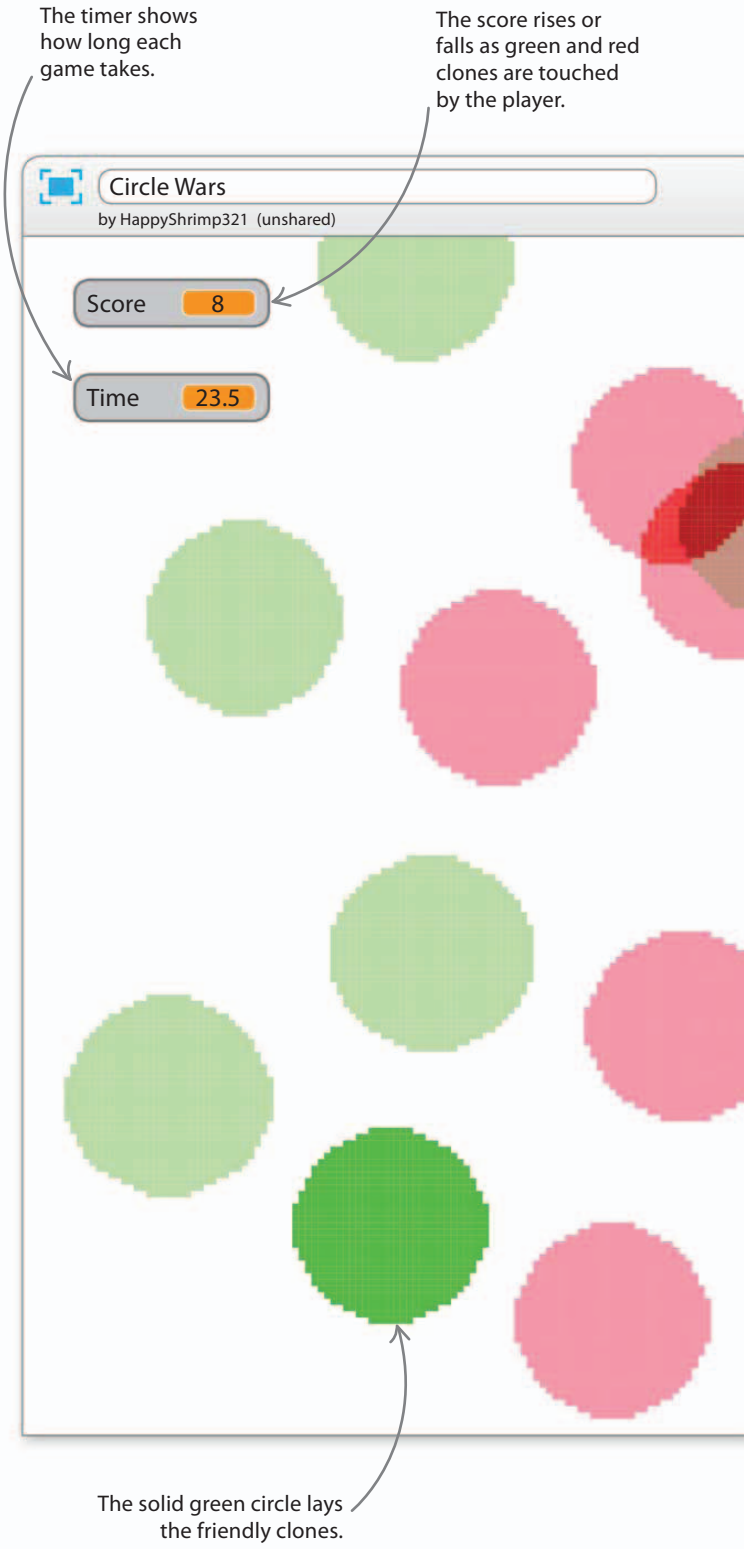
AIM OF THE GAME

Move the blue circle around the screen using the mouse. Collect the pale green circles, but avoid the red ones that march toward you like a zombie army. The solid green and solid red circles drop clones of themselves as they roam around. Score more than 20 points to win and go below –20 to lose.

◁ **Player**
The player is the blue circle. If you don't keep moving quickly, the enemy circles will soon overwhelm you.

◁ **Friends**
The friendly circles are green. When you touch one, you score a point and the circle disappears with a pop.

◁ **Enemies**
Steer clear of the red enemy circles. Touch one and it takes three points off your score, before vanishing with a clash of cymbals.



The solid red circle lays the enemy clones.

Click the green flag to start a new game.

Click the stop sign to end a game.

Player

Clones of the solid red circle chase the player.

Clones of the solid green circle chase the player.

GAME CONTROLS

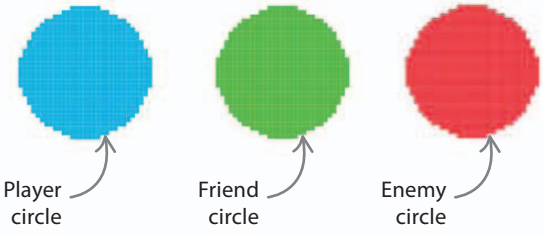
Use a computer mouse or touchpad to control this game.

◁ **Is it art?**

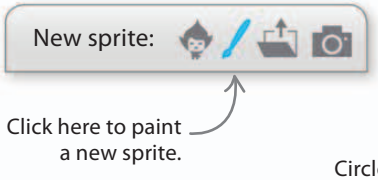
Not all games use cartoon sprites. With its colored circles, this game looks more like a piece of modern art. Once you've built it, why not make up a story to explain the game. You can change the sprites, colors, and backdrop to tell that story.

Creating the sprites

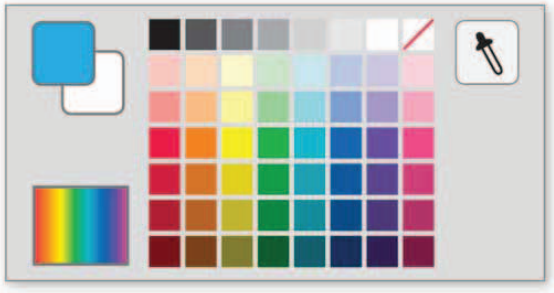
First you need to create the three sprites for the main game. These are all simple colored circles, so you can draw them yourself. Start by following these instructions to create the player's character—the blue circle.



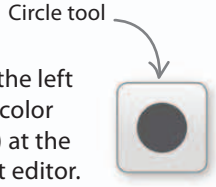
1 Start a new project and name it "Circle Wars". Click the paintbrush symbol at the top of the sprites list to paint a new sprite.

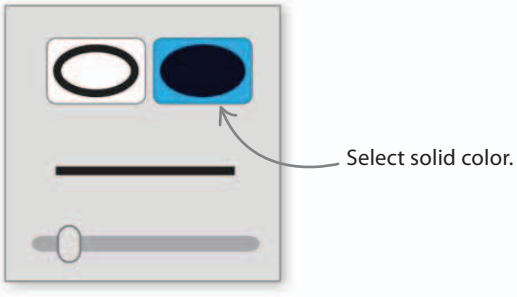


2 To draw a blue circle, first select "Bitmap Mode" (bottom right). Then choose blue in the color palette.



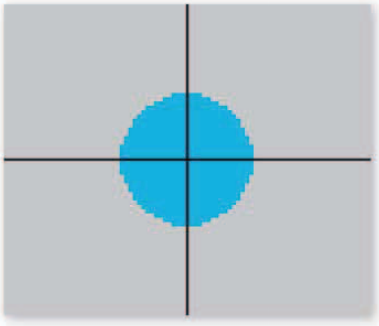
3 Click the circle tool on the left and then select a solid color (rather than an outline) at the bottom left of the paint editor.





4 While holding down the shift key (this gives you a circle rather than an oval), click with the mouse and drag to draw a circle. The circle should be about the size of the cat's head. When you're happy with the circle's size, delete the cat sprite (right-click on it and select "delete").

5 You now need to center the sprite. Select the "Set costume center" tool (top right) and then click in the very center of the circle. Rename the sprite "Player" by clicking on the blue "i" in the sprites list.



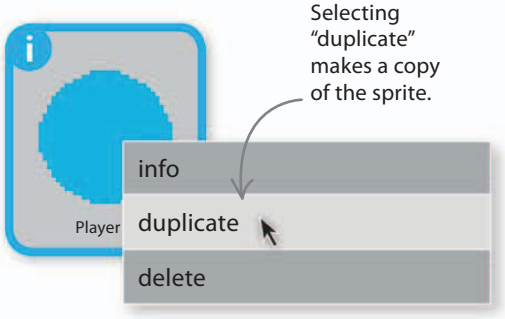
EXPERT TIPS

Resizing the circle

If your circle is too big or too small, you can change the size of it by selecting either the "Grow" or "Shrink" tool on the bar along the top of the Scratch screen, then clicking on the circle.

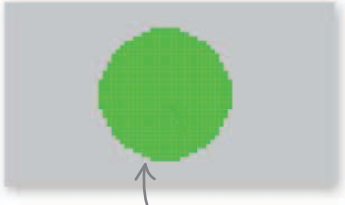
Making friends and enemies

You can now make the green friend and red enemy circles. You can use other colors if you like, but make sure you can easily tell the three different circles apart.

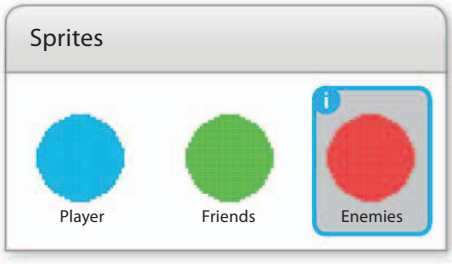


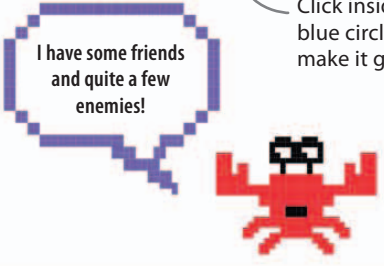
6 Start by right-clicking on the Player sprite and selecting "duplicate". Do this twice. You'll now have three blue circles. Rename Player2 as "Friends" and Player3 as "Enemies".

7 Select the Friends sprite and click the Costumes tab. Choose green in the color palette. Select the "Fill with color" tool and click inside the blue circle to make it turn green.



8 Repeat the steps for the Enemies sprite, but color this sprite red. You should now have three different colored sprites.

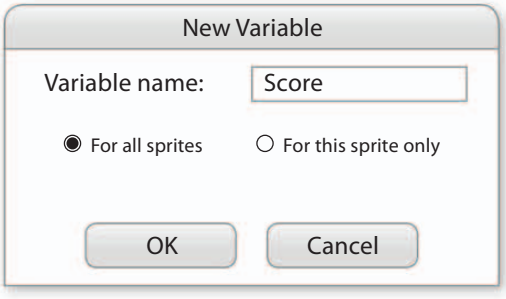


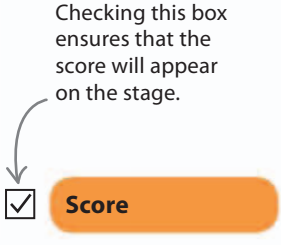


Instant player control

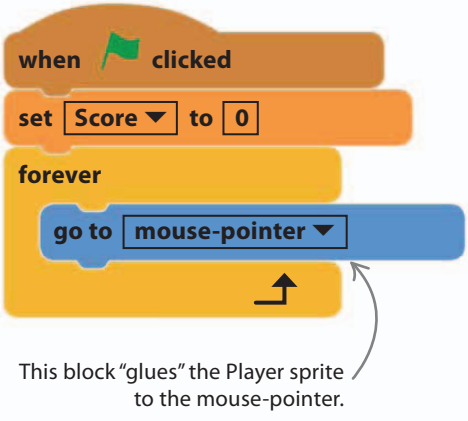
Now add a score display and a script to make the Player sprite stick to the mouse-pointer—just like in Star Hunter.

9 Select the Player sprite, click Data, and make a variable called "Score" for all sprites. Then put a check in the variable's box to show "Score" on the stage.



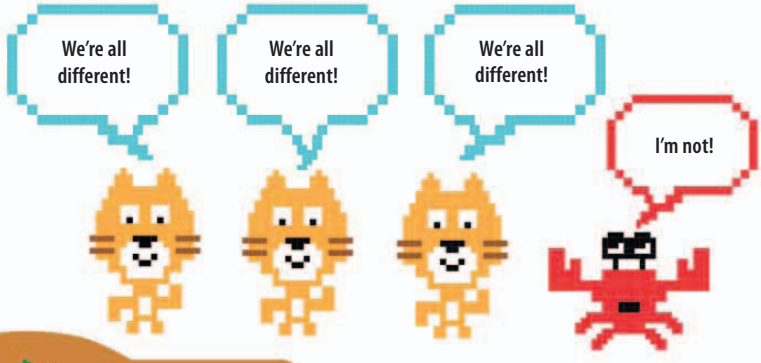


10 Add the script below to get the blue circle following the mouse. Read it through and make sure you understand what it does. Run the script to check it works. The red and green circles won't do anything yet.

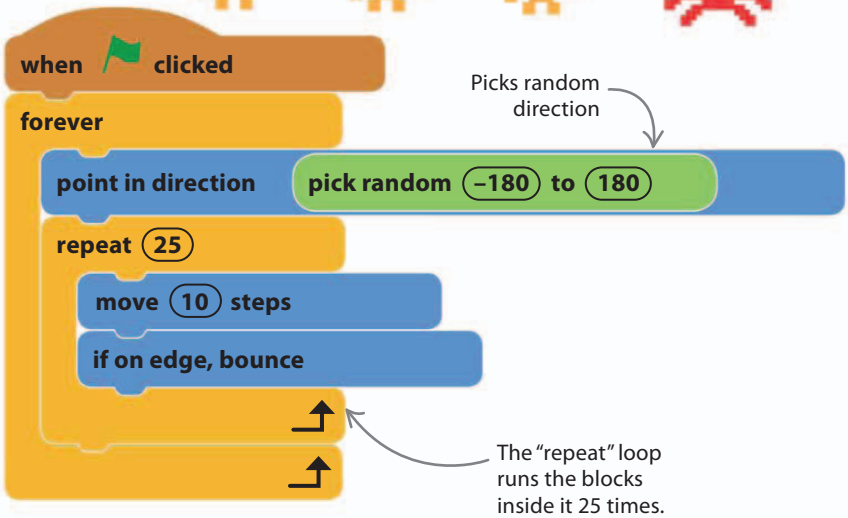


March of the clones

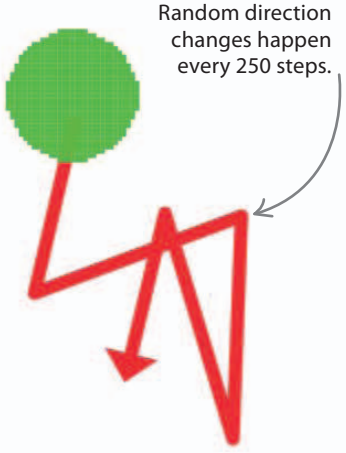
From just two sprites—the green and red circles—you can create an army of friends and enemies to pursue the player's blue circle. You can do this through the magic of cloning. Before you create your clones, first get the Friends sprite moving randomly around the stage.



11 Select the green Friends sprite. Add this script to make the circle bounce around the stage with a random change of direction every 250 steps.



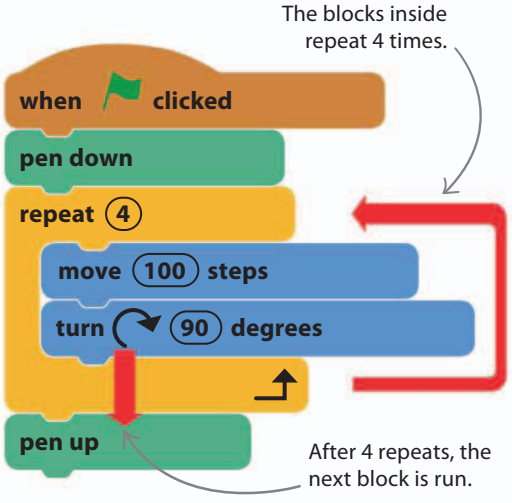
12 Run the project and watch the green circle's unpredictable journey. The Friends sprite moves 250 steps in 10-step jumps but it doesn't get stuck to the walls. After 250 steps, the "forever" loop goes back to the start. The sprite changes direction randomly and sets off again.



EXPERT TIPS

Repeat loops

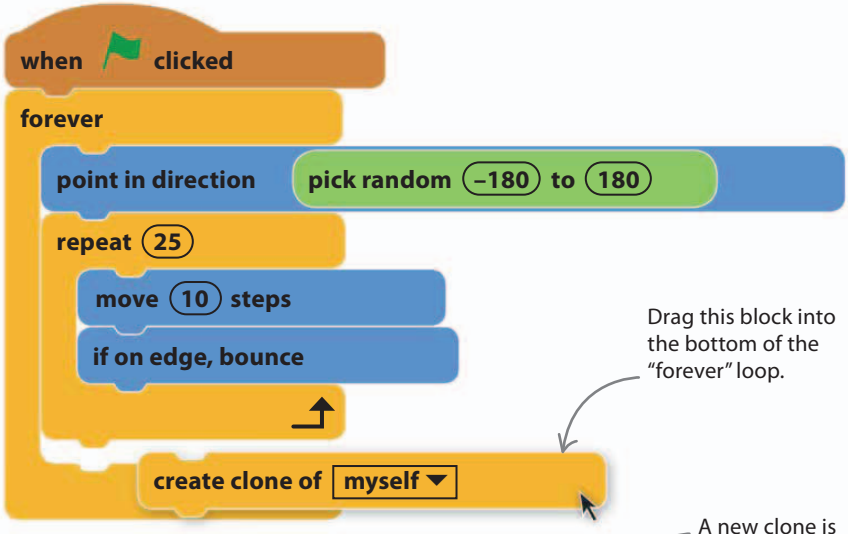
You've already seen "forever" loops that repeat a group of blocks nonstop. A "repeat" loop does a similar job, but it only repeats the blocks inside a fixed number of times. This type of loop is sometimes called a "for" loop, because it repeats *for* a certain number of times. The example shown here repeats an action four times to draw a square.

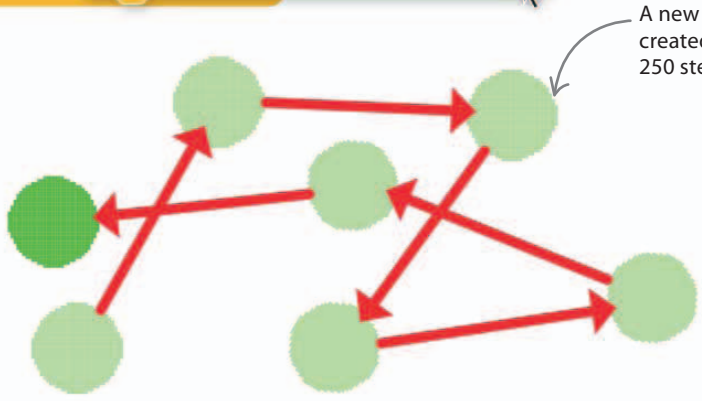


Making clones

Now we're going to make our friendly clone army. These are the clones you need to catch to score points.

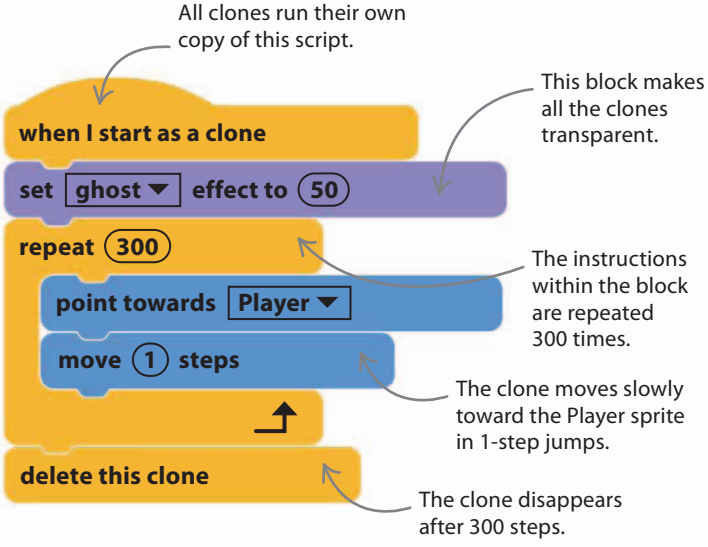
13 Add a "create clone of myself" block as the last block in the "forever" loop. You'll find it in the yellow Control section. This block will create a clone of the Friends sprite after each 250-step movement.





14 Run the project. At each change of direction, the sprite leaves a copy of itself—a clone. The clones aren't just pictures—they are fully working copies of the original sprite, and you can give them their own instructions.

15 New clones are controlled by a special script that starts with the block "when I start as a clone". Add the script below to the Friends sprite. The script tells each clone to move toward the Player sprite for 300 steps, after which the clone is deleted and vanishes from the stage. The clones move one step at a time. They move more slowly than the original Friends sprite, which moves in 10-step jumps.

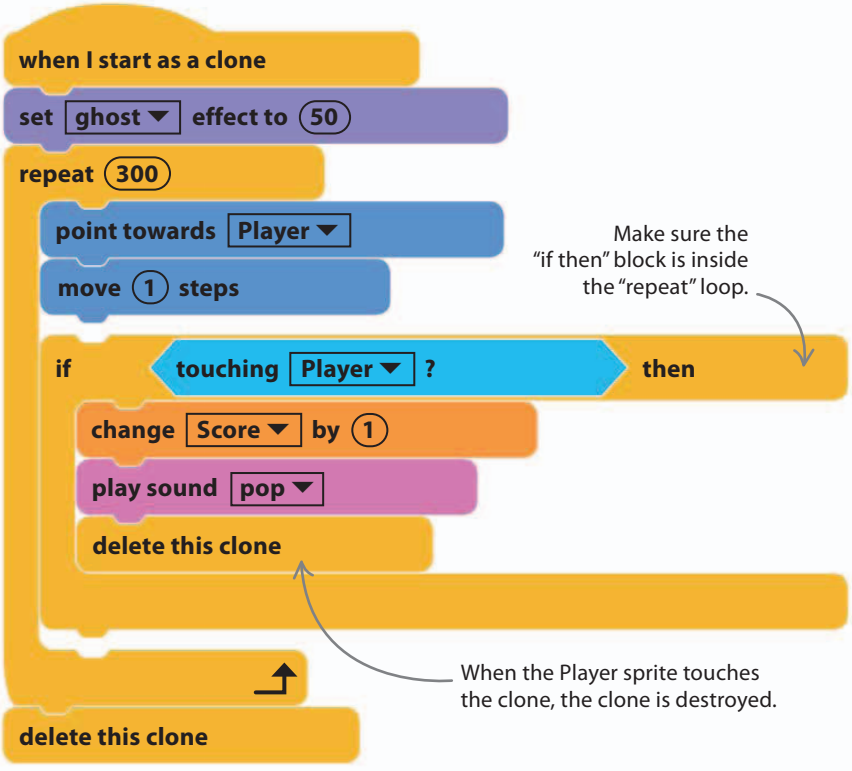


16 Run the script and watch the green clones advance slowly toward the Player sprite. Don't worry—they're the good guys!

Destroying clones

The last part of the script for the Friends clone checks if the clone is touching the Player. If it is, the clone gets deleted.

17 Add an "if then" block containing the blocks shown here to check whether the clone is touching the Player sprite after each move. Try running the project now—the score should increase as you touch green circles, which instantly disappear with a pop.



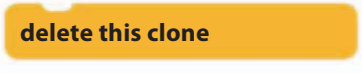
EXPERT TIPS

Clones

Clones are useful any time you want lots of copies of a sprite. Many programming languages let you make copies of things, but they are often called objects rather than clones.

Such languages are called "object oriented" languages and include Java and C++. In Scratch, there are three orange blocks that control clones, all found in the Control section.

△ This block creates a clone of the sprite. The clone is identical to the sprite and appears in the same position and facing the same direction, so you won't be able to see it until it moves.

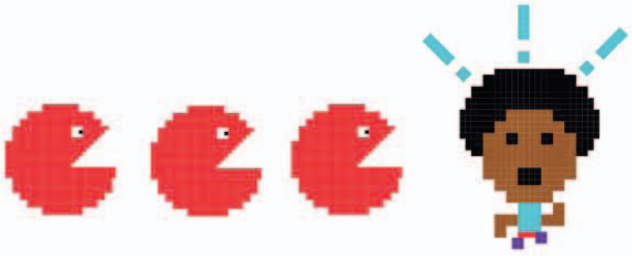


△ This block gets rid of the clone. All clones disappear from the stage when a project stops, leaving just the original sprite.

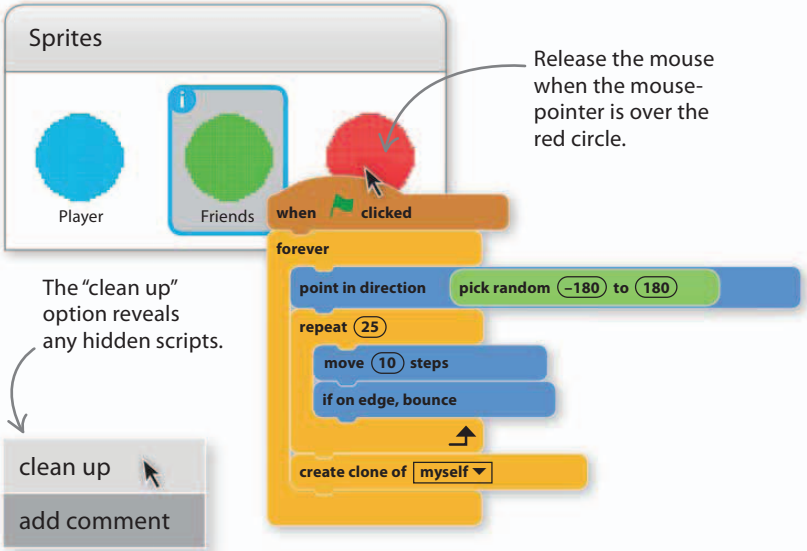
△ When a clone starts, it runs the script headed with this block. Clones don't run the sprite's main script, but they can run all other scripts in the sprite's scripts area, such as scripts triggered by messages.

Enemy clones

Now you need to add scripts to the Enemies sprite to make it produce clones that chase the Player. You can do this by copying the scripts from the Friends sprite across to the Enemies sprite.

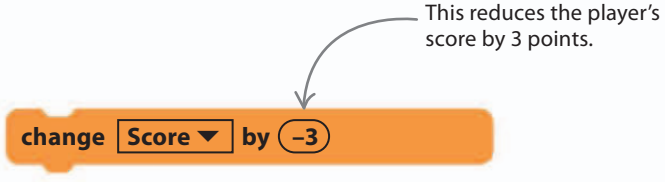


18 To copy scripts, just click, drag, and drop scripts from one sprite onto another. Drag the two scripts you made for the Friends sprite onto the Enemies sprite, one at a time. This makes copies of the scripts in the Enemies sprite.

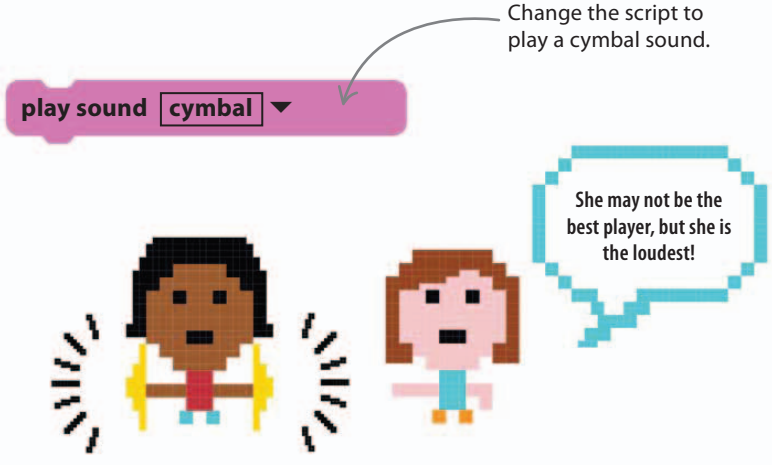


19 Select the Enemies sprite. The scripts you dragged and dropped will probably be on top of one another, because any copied script just appears at the top left of the scripts area. To rearrange them, right-click on the background and select "clean up".

20 Now adjust the Enemies clone script so that it takes points away when the Player touches a red clone. Alter the "change Score by" block so it changes the score by –3 instead of +1. You really want to avoid those nasty red enemies!



21 Add a sound to tell the player that points have been lost. Load the cymbal sound into the Enemies sprite by selecting "cymbal" in the sound library. Alter the script to play "cymbal", not "pop". You'll now hear which type of clone you've touched.

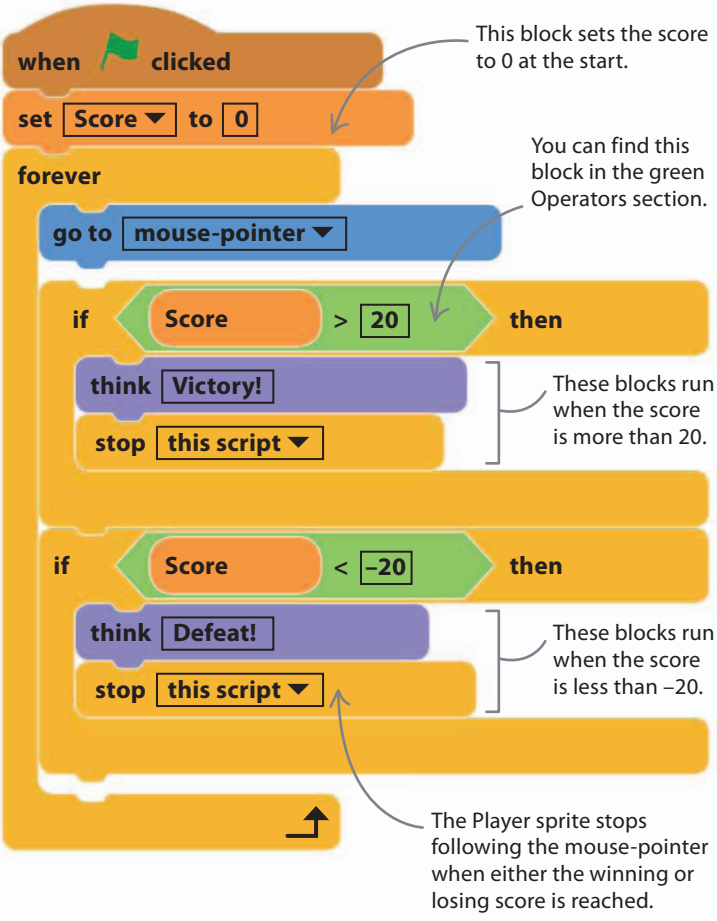


22 Run the project. Check that you now have both red and green clones, and that touching a red clone takes 3 points off your score.

Win or lose?

You've created two ever-expanding clone armies: one of friendly circles that help you win points, and one of evil circles that make you lose points. Next you need to add the code that tells you if you've won or lost the game.

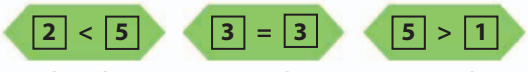
23 Add the new "if then" blocks shown here to the Player sprite. They check your score. If the score is greater than 20, you win, and a thought bubble with the word "Victory!" appears. If the score is less than –20, you lose, and the sprite thinks "Defeat!"



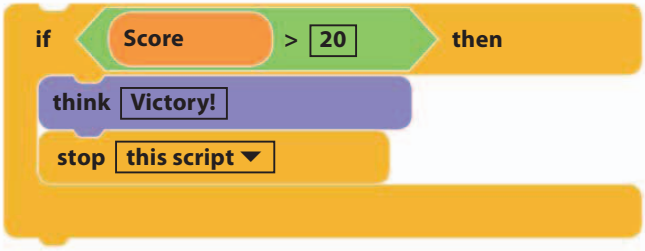
LINGO

Comparison operators

Earlier we saw how you can use "if then" blocks to create true or false statements—also known as Boolean expressions—that lead to different outcomes. For example, in Star Hunter, "if touching cat then play sound fairydust" makes a sound play only when the cat gets a star. We can do the same thing with numbers by using what are called comparison operators:



When we add these to "if then" blocks, they create statements that are either true or false. In Circle Wars, the "is more than" operator tells you that you've won the game when you score over 20.



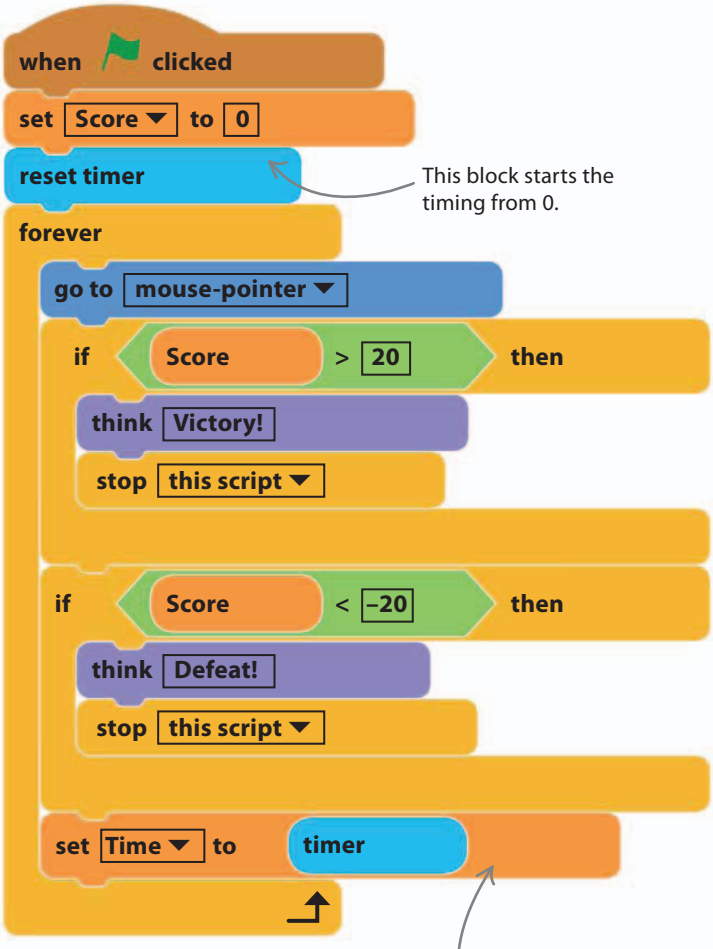
24 Run the game. Try to touch only the green circles. Check that the game ends when the key scores are reached, and check that the Player sprite thinks "Victory!" or "Defeat!" You can reduce the score needed to win if you find it too difficult. But don't make the game too easy—Circle Wars is meant to be a challenge!

Adding a timer

To add some competition to the game, you can include an on-screen timer that shows players how long they take to complete a game.

25 Click on the Data section and make a variable "Time" for all sprites. To show it on the stage, check the box next to the variable's block. Select the Player sprite. Click on Sensing in the blocks palette. Add "reset timer" to the Player's script, just before the "forever" loop. Go back to Data and drag a "set Time to" block to the script and add "timer" to it, making it the last instruction in the forever loop.

26 By copying "timer" to the variable "Time", each trip around the loop will now display the time on the stage. But the moment the player wins or loses, the time stops being updated (the script is stopped) and the total time it took to win or lose is shown.



Instructions

Players need to know the rules of the game. Create a special sprite that shows the instructions for Circle Wars when the game begins.

27 Use the paintbrush symbol to create a new sprite and rename it "Instructions". Select "Bitmap Mode" and choose a color. Select the "Fill with color" tool and click on the drawing area to fill it with your chosen color.

"Fill with color" tool

28 Now select black from the palette as the color for the text. Then choose the text tool and type out the instructions shown here.

Text tool

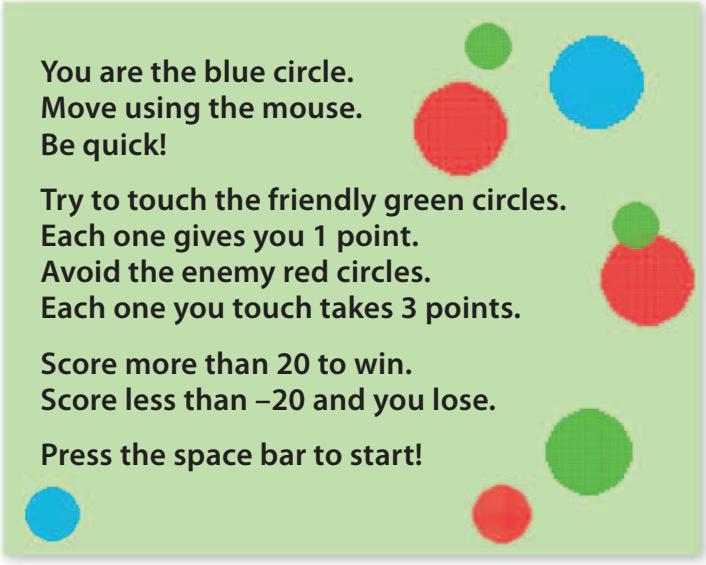
29 If the text doesn't fit, use the select tool to resize it by pulling the corner points in or out. When you've finished, click outside the box around the text to stop editing.

"Select" tool

Use black for the text.

Choosing a light background color will make the text easier to read.

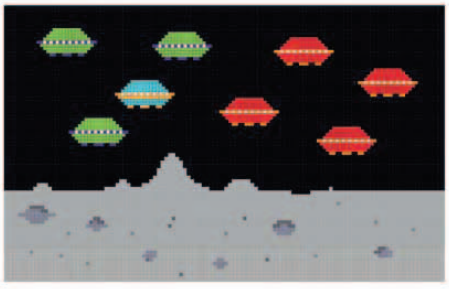
You may want to decorate your instructions with colored circles.



GAME DESIGN

Game stories

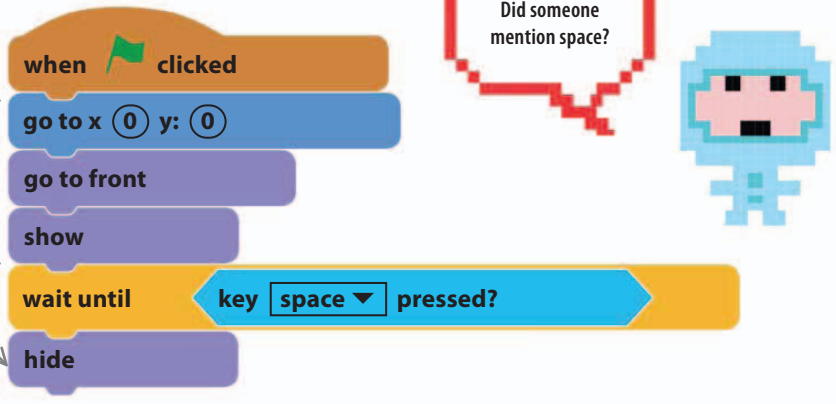
Computer games usually have a story to explain why the action in the game is happening. At the moment, Circle Wars has no story. Can you make one up? It could be a battle in space, with a blue spaceship saving friendly green spaceships and trying to avoid being hit by the red enemy craft. Let your imagination run riot! Including some of the story in your instructions will help make the game more interesting and exciting for the player.



30 Add this script to the sprite to show the instructions on the stage at the start of the game. Read it carefully. Can you see how it works?

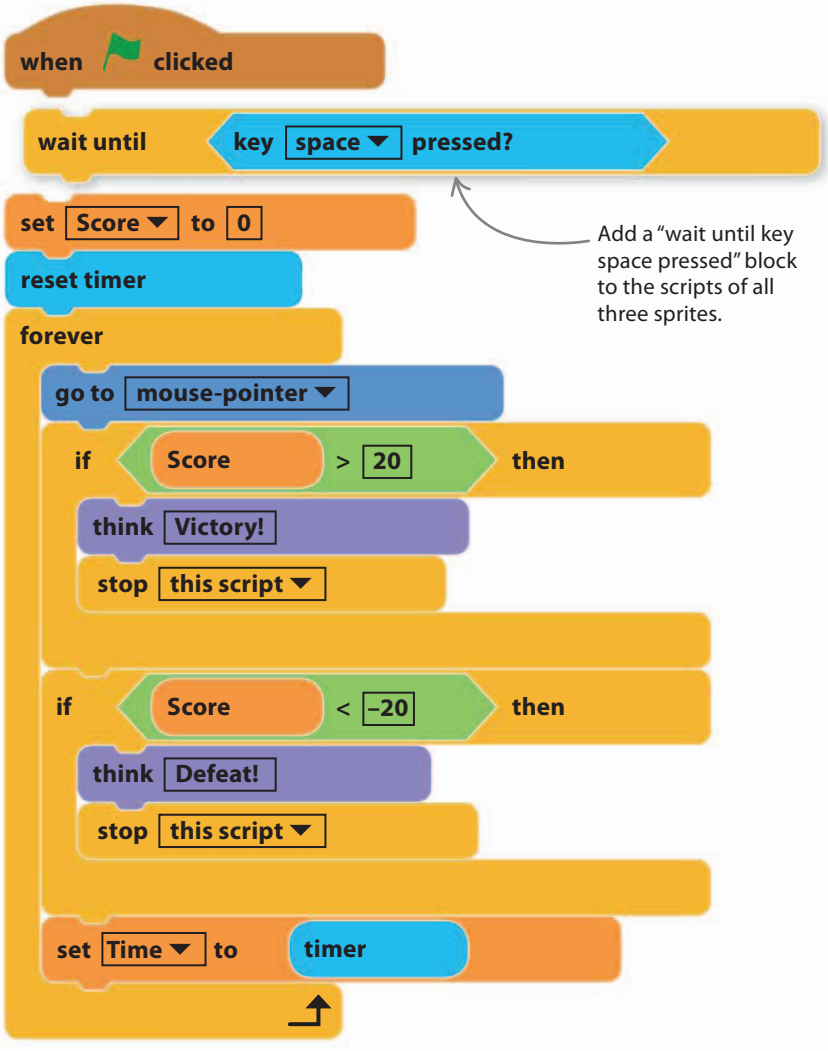
These blocks show the instructions in the center of the screen in front of other sprites.

This block hides the Instruction sprite when the player presses the space bar to start playing.



31 You also need to add a "wait until key space pressed" block immediately after the green flag blocks in the Player, Friends, and Enemies sprites' scripts. This will hold back all the action until the space bar is pressed.

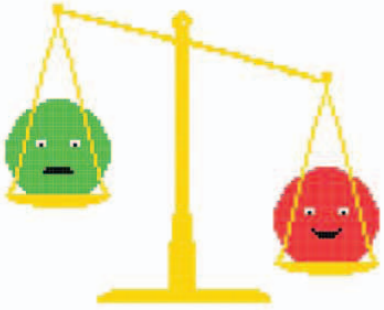
Add a "wait until key space pressed" block to the scripts of all three sprites.



32 Run the project and your instructions should appear, filling the screen until you press the space bar. Players will have plenty of time to read and understand the instructions, letting them start the game when they're ready.

Hacks and tweaks

You've got Circle Wars working—well done! Now to personalize it and make it your own. Try these suggestions and your own ideas. Once you've created something unique, why not share it on the Scratch projects website?



△ **Find a balance**

Experiment with different speeds, or change how many points you win or lose for touching Friends and Enemies. It's not difficult to make the game very hard or very easy, but can you find a balance to make it just the right level?

▽ **What's the story?**

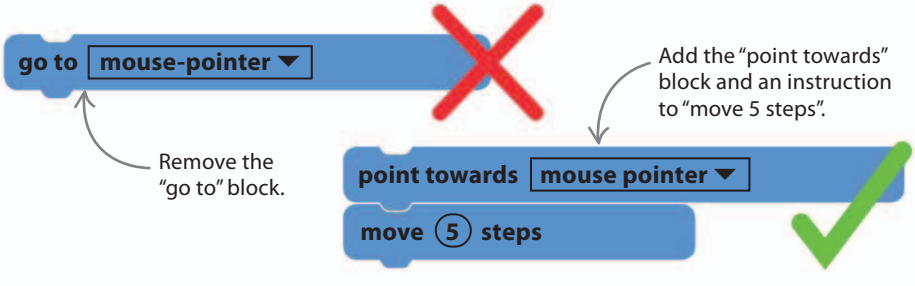
Did you think of a story to explain what's going on in Circle Wars? Maybe it's the attack of the dragons, and the princess player has to eat cakes to survive? Add some scenery and music to the game to fit with that story. Experiment with different stories and looks.

▷ **The war's over!**

Add a broadcast message to reveal a "Game over!" sprite when the player wins or loses, like you did in Cheese Chase. You can change the text of the "Game over!" sprite so that it relates to your story about the game.

▷ **Slow down, blue!**

To make things tricky, change the blue circle's script so that it no longer "sticks" to the mouse pointer but chases slowly after it. You could also invent simple keyboard controls for the sprite.



▽ **Tweak the timer**

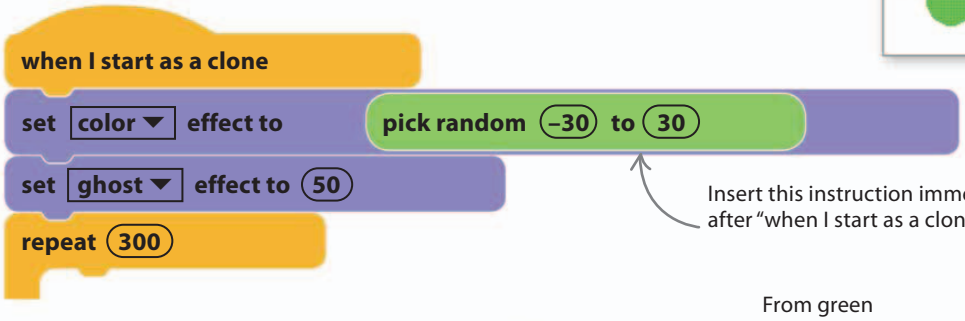
The number in the timer flickers because it shows lots of decimal places. To round the value so it shows only whole seconds, use the green "round" block near the bottom of the Operators section. Try adding a "Best time" for winning players, just as you added a "High score" in Cheese Chase.

▽ Change the colors

Vary the clones' colors. Click on the Friends sprite. Add the "set color effect to" block from the Looks section to the sprite's clone script. Then drag "pick random" from Operators into the block's window and change the values to –30 and 30. Do the same for the Enemies sprite. New clones will now have different colors!

Green and blue circles are friends.

Orange, yellow, pink, and purple circles are enemies.

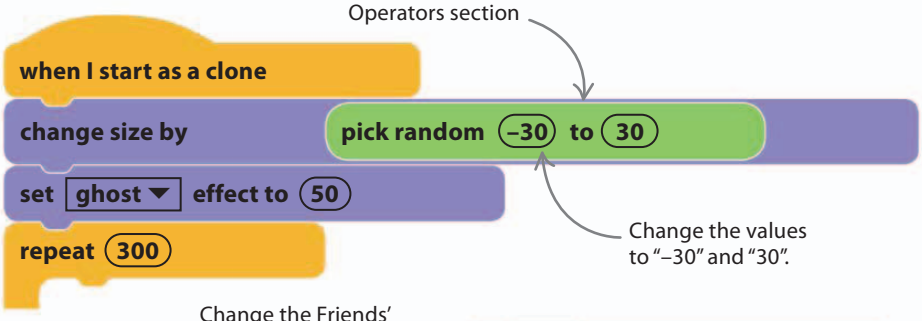


Insert this instruction immediately after "when I start as a clone".

▷ Change the size

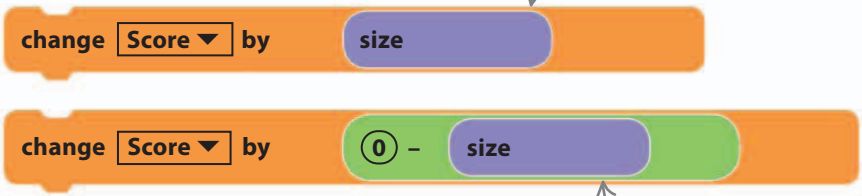
Add the "change size by" block to the scripts of both the Friends and Enemies sprites to make each clone a random size. Alter the scoring so that the size of the circle you touch determines how many points you score. You'll also need to change the totals needed to win or lose. Try more than 2,000 points for victory, and less than –2,000 for defeat.

From green Operators section

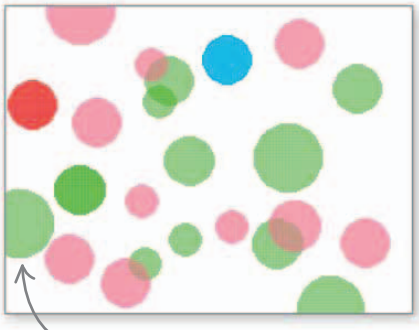


Change the values to "–30" and "30".

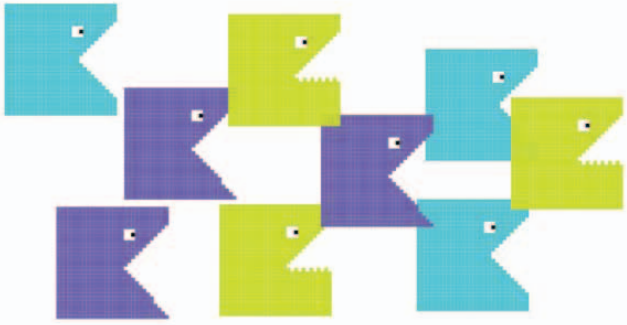
Change the Friends' score value to this.



Use this scoring for Enemies.



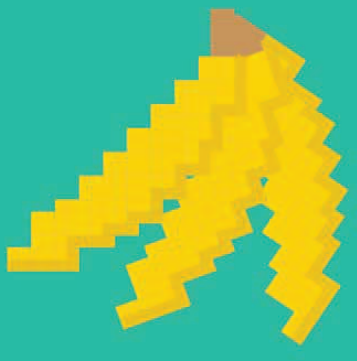
The bigger the clone, the more points you win or lose.



◁ Shape shifting

Introduce another shape into the game. It could be a square that eats red circles, a triangle that runs away from the player, a hexagon that makes the player shrink or grow, or anything else you want to try.

Jumpy Monkey



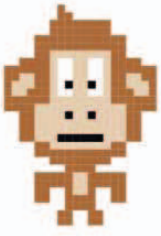
How to build Jumpy Monkey

In the real world there are laws you just can't break. For example, the law of gravity means that something that goes up must always come down again. Jumpy Monkey shows you how to add gravity to your game worlds.

AIM OF THE GAME

The monkey is on a mission to collect bananas. Choose which direction he leaps in and how fast he goes. You need to send him over the palm tree to grab the bananas using the fewest possible jumps.

◁ **Launcher**
Point this arrow in the direction you want to launch the monkey by using the left and right arrow keys.



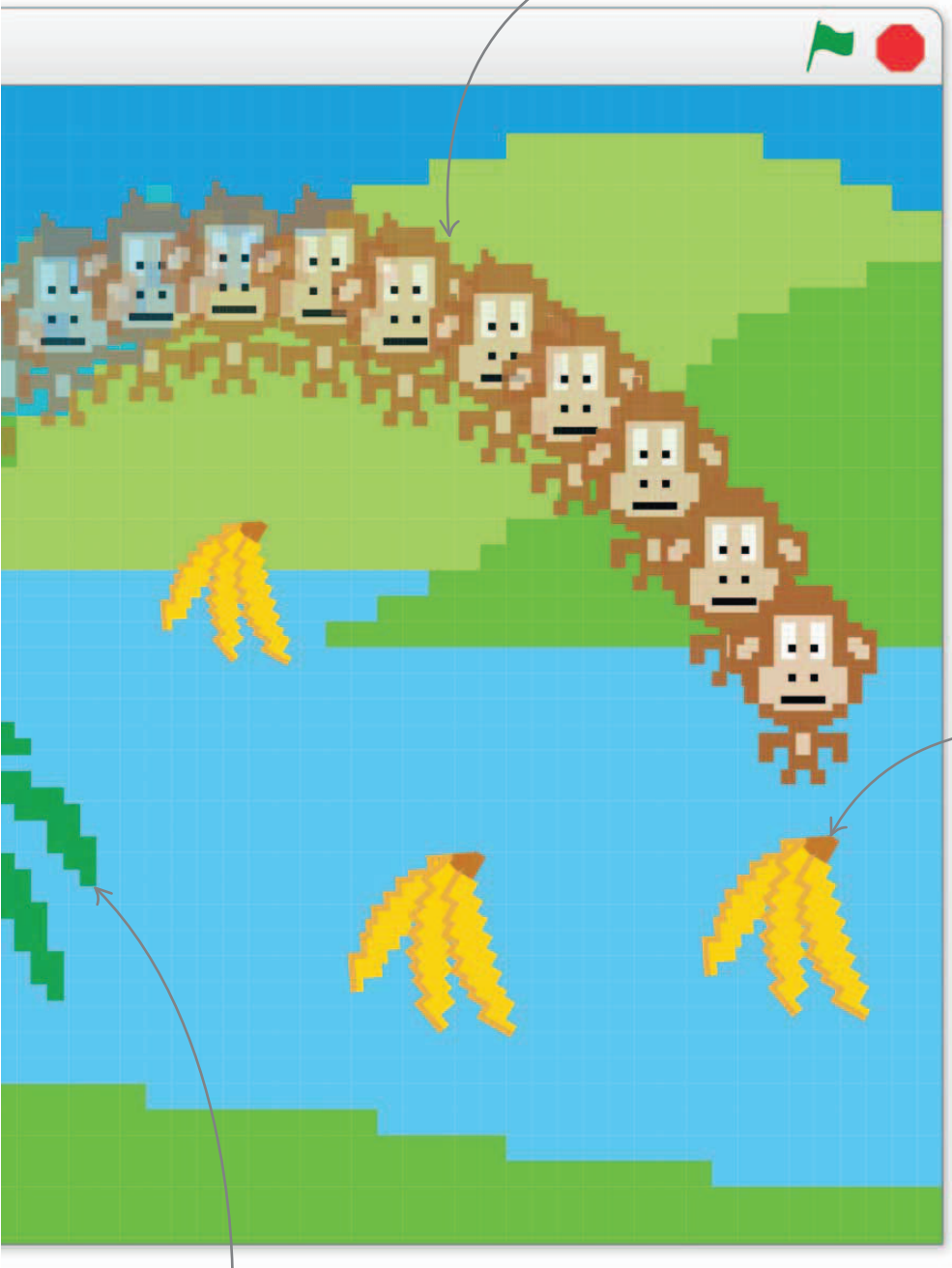
◁ **Monkey**
Select the monkey's launch speed with the up and down arrow keys, then press the space key to launch him.

◁ **Bananas**
If the monkey touches any of the bananas he will eat them. Keep going until he eats all the bananas.

The instructions appear on the game at the start.

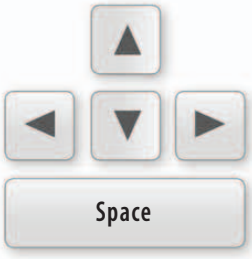
The monkey is launched from the arrow when you press the space key.

This number shows you how fast the monkey will fly once he is launched.



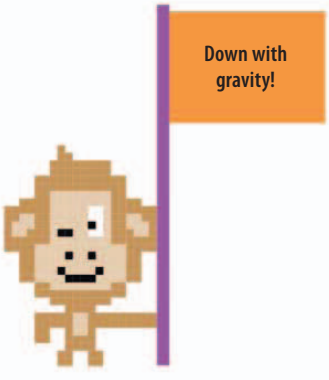
GAME CONTROLS

Players use the arrow keys and space key on the keyboard as game controls.



◁ **Flying monkey**

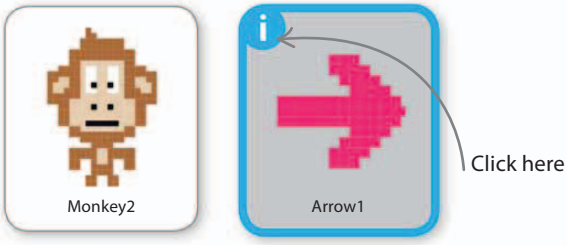
Try to collect all the bananas using as few launches as possible. The game will record how many launches you use.

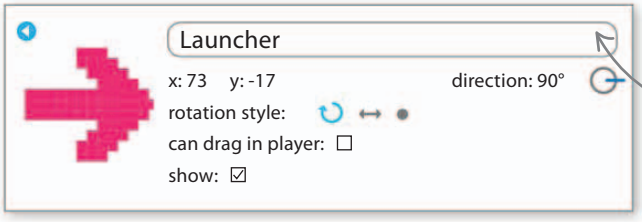


Launching the monkey

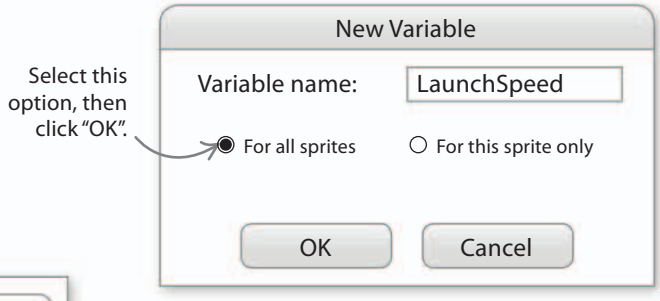
This game uses a big arrow to help the player choose the monkey's precise launch direction. We'll ignore gravity to start off with, but you'll need to add it later to get the monkey past the tree.

1 Start a new project and call it "Jumpy Monkey". Delete the cat sprite and load two sprites from the library—"Monkey2" and "Arrow1". Select the arrow sprite and rename it "Launcher" by clicking on the "i" and typing the new name into the box.

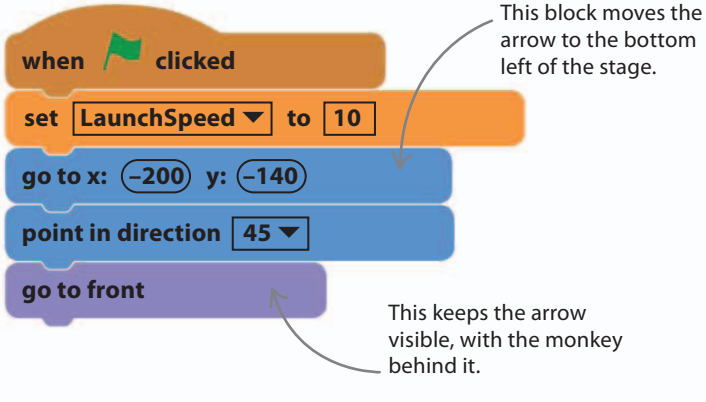


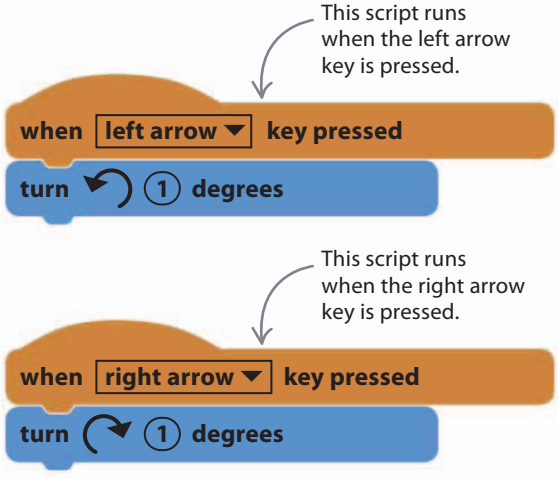


2 Go to Data, select "make a variable", and add a variable called "LaunchSpeed". The new variable will automatically show up on the stage.

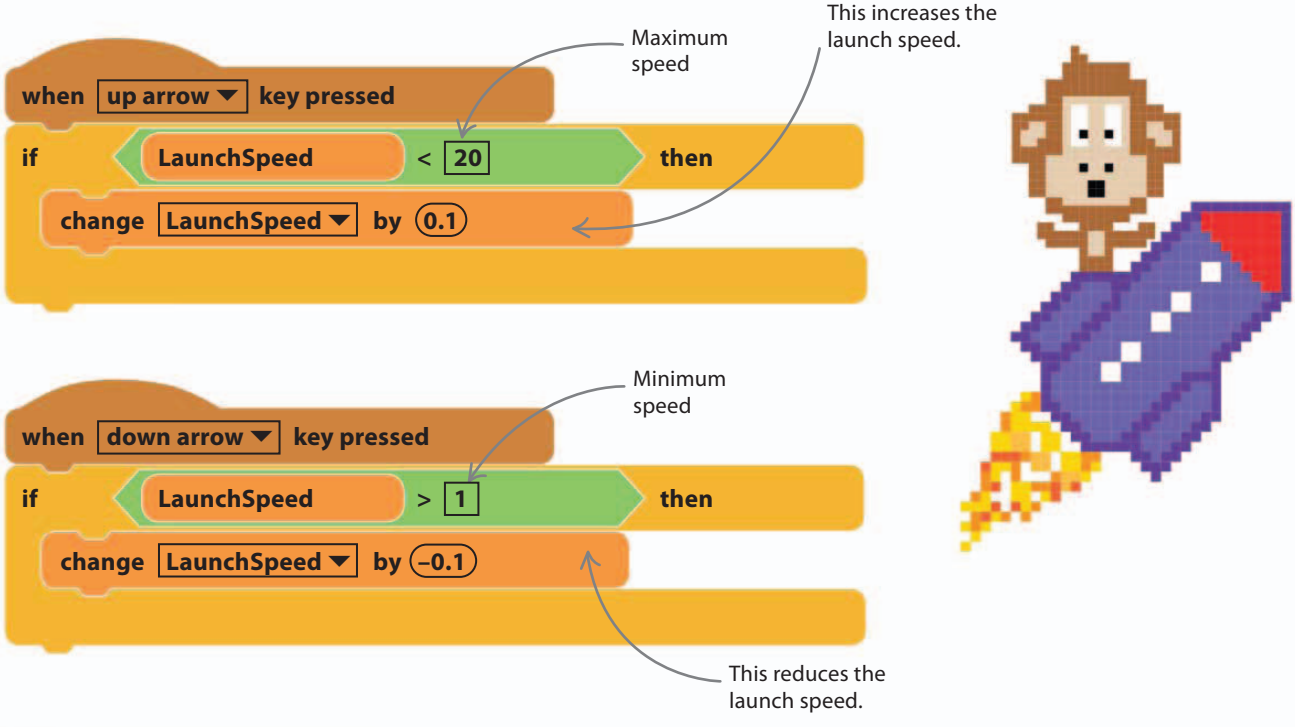


3 Select the Launcher sprite, then add these three scripts to set up the Launcher and allow the player to control its angle using the left and right arrow keys on the keyboard. The direction of the arrow is the direction that the monkey will launch. Run the scripts and try turning the arrow.





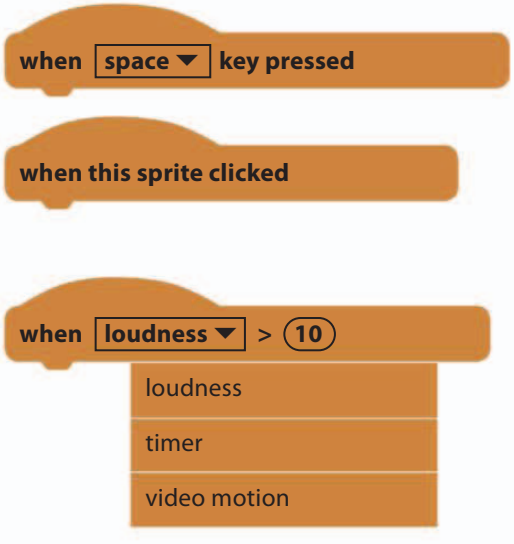
4 Now that you can aim, you need controls to set the speed of the launch. Add these scripts to change the speed using the up and down arrow keys.



LINGO

Events

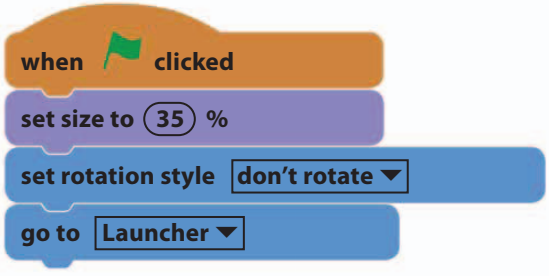
The key presses and mouse clicks that a computer detects are known as events. The brown Events blocks in Scratch trigger a script whenever a particular event occurs. We've seen them used with messages in Cheese Chase, but Scratch also lets you trigger scripts using keys, mouse clicks, sound levels, and even movement detected by a webcam. Don't be afraid to experiment.

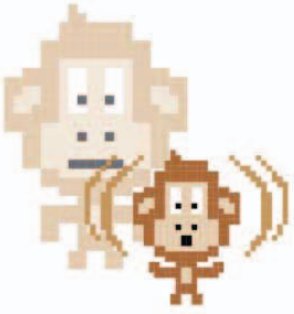


▷ **Setting things off**

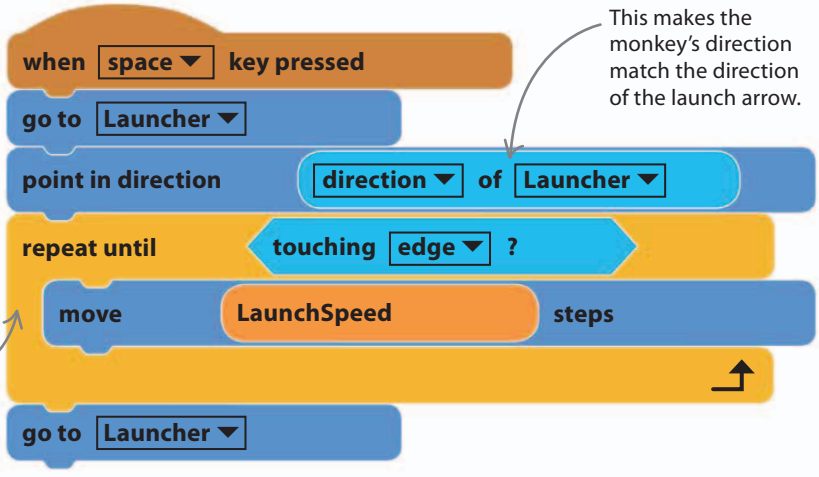
Events blocks such as these are used to trigger a script whenever the event they describe occurs.

5 Now select the Monkey sprite. Add this script to shrink him down to the right size and move him behind the Launcher.





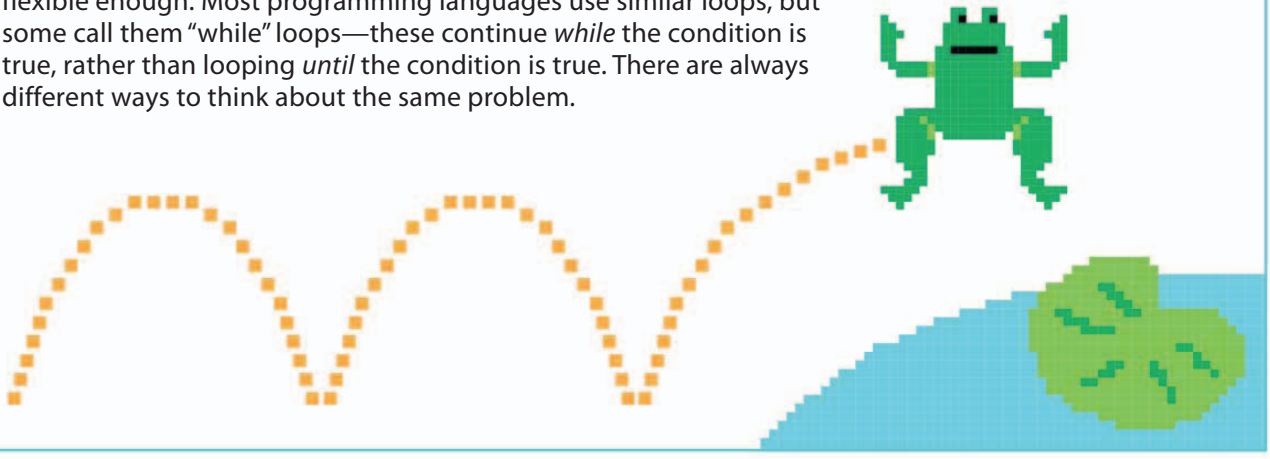
6 To launch the monkey when the space bar is pressed, add this new script to the Monkey sprite. "Repeat until" is a new type of loop block that keeps repeating the block inside until the condition becomes true—in this case, the monkey keeps moving until it touches the edge of the stage.



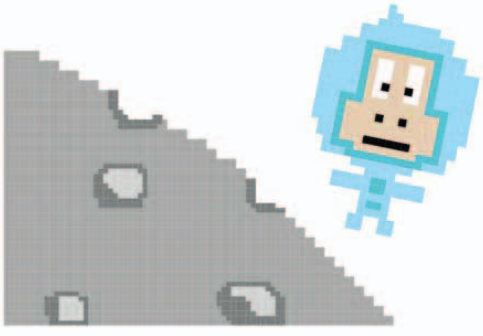
EXPERT TIPS

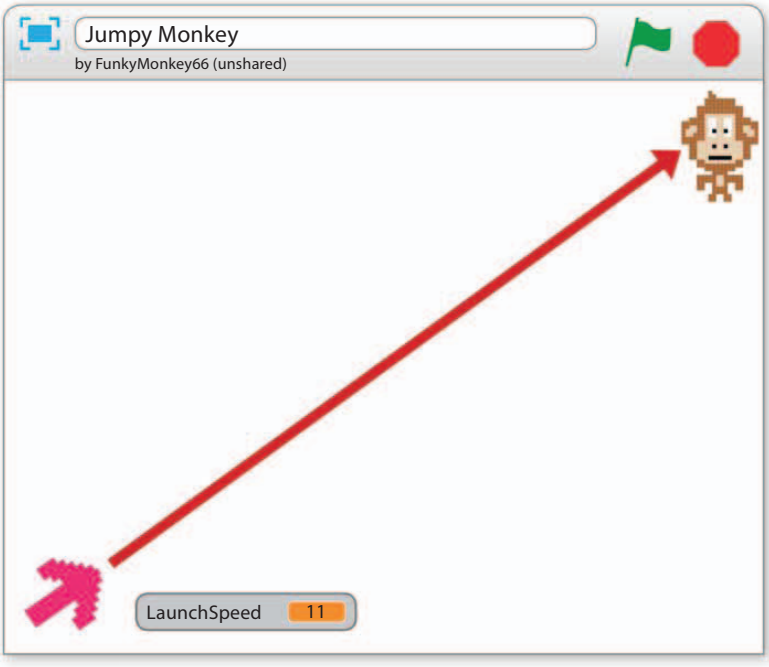
"repeat until"

Do you want to keep repeating an action only until something happens and then move on to the rest of the script? The "repeat until" block can help your code when "forever" and "repeat" loops aren't flexible enough. Most programming languages use similar loops, but some call them "while" loops—these continue *while* the condition is true, rather than looping *until* the condition is true. There are always different ways to think about the same problem.



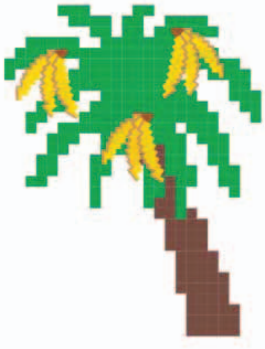
7 Try setting the Launcher angle and speed using the arrow keys, and pressing the space bar to fire the monkey. He goes in a completely straight line until he hits the edge of the stage. Real things don't do this—they fall back toward the ground as they move. We'll add gravity to the game later to make the monkey behave realistically.



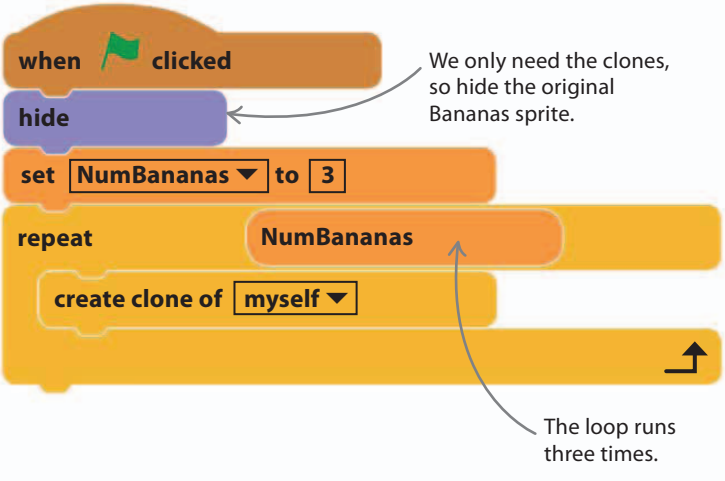


Bananas and palm trees

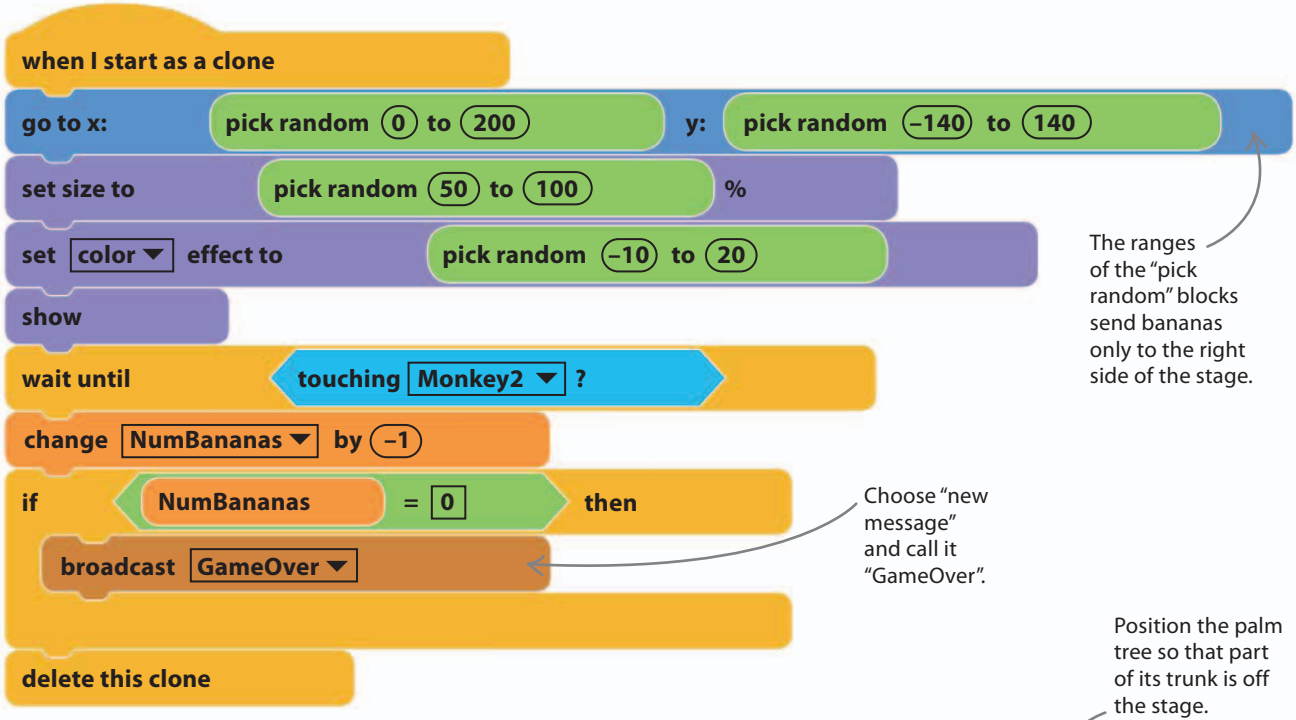
The point of this game is for the monkey to collect bananas. By using clones, you can add just one Bananas sprite but give the monkey plenty of fruit to aim for.



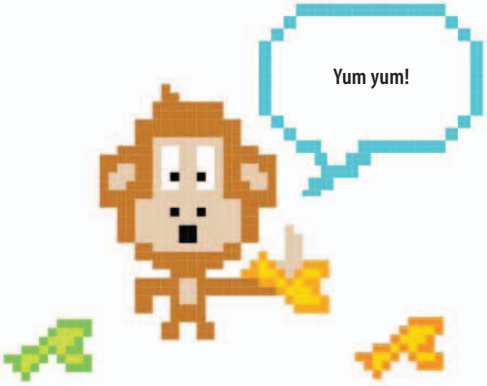
8 Add the Bananas sprite to the project. Make a variable for all sprites called "NumBananas" to keep track of the number of bananas on the stage—start with three. Build the following script to clone the bananas, but don't run it yet because you still need to tell the clones what to do.



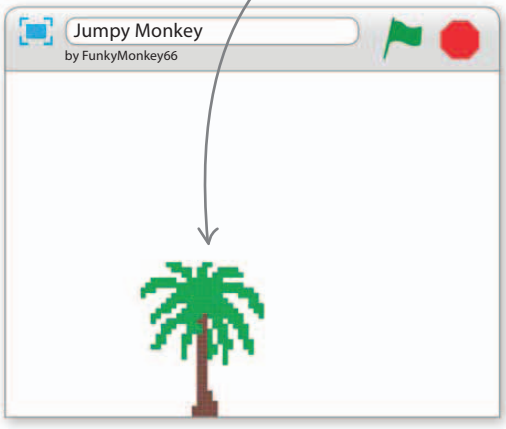
9 Add the next script to place each banana clone in a random spot on the right of the stage, change how it looks, and make sure it's not hidden. The clone will wait for the monkey to touch it and then disappear. If it's the last banana, it sends a "GameOver" message, which you need to create as a new message.



10 Run the project. You should be able to get the monkey to collect all the bananas. There is no script run by the "GameOver" message yet.

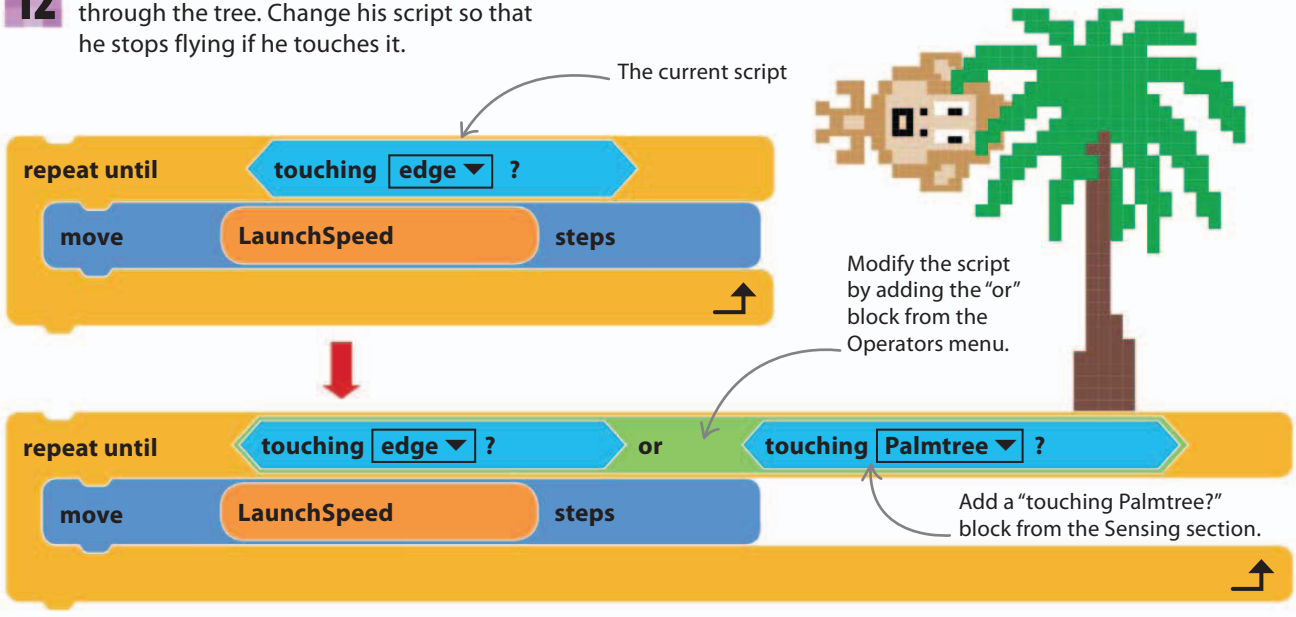


11 The game is too easy—we need an obstacle. Add the Palmtree sprite to the project. Drag and drop the tree at the bottom of the stage.

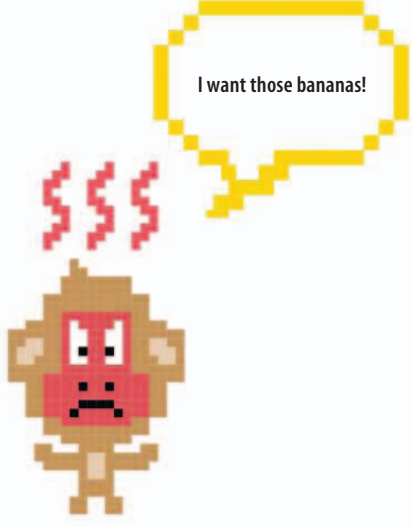


△ **Tree on stage**
Make sure your palm tree is slightly off-center, toward the left of the stage, or the bananas will get stuck behind the tree and the game won't work.

12 At the moment, the monkey can fly straight through the tree. Change his script so that he stops flying if he touches it.



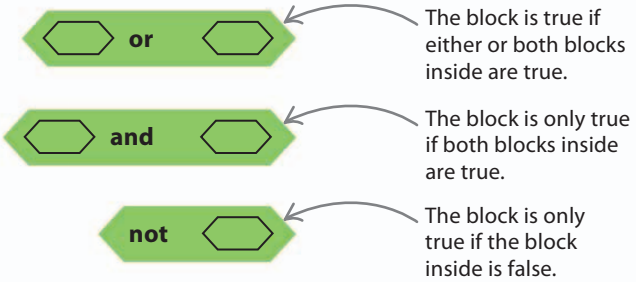
13 Run the project. The monkey should stop flying when he hits the tree, which makes any bananas to the right of the tree impossible to reach. Don't worry, gravity will come to the rescue soon.



EXPERT TIPS

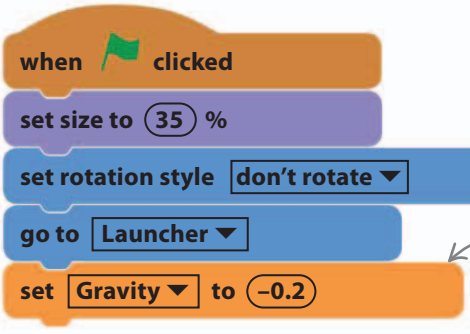
"or", "and", "not"

So far, most of the "if then" blocks in this book have tested only a single condition, such as "if touching cat" in the Star Hunter game. In this chapter, however, you need to test two conditions at once: "touching edge or touching Palmtree". Complex sets of conditions like this occur a lot in coding, so you need a way to combine them. In Scratch, the green Operators blocks do the job. You'll see words like "or", "and", and "not" in almost every programming language, or special symbols that do the same job.



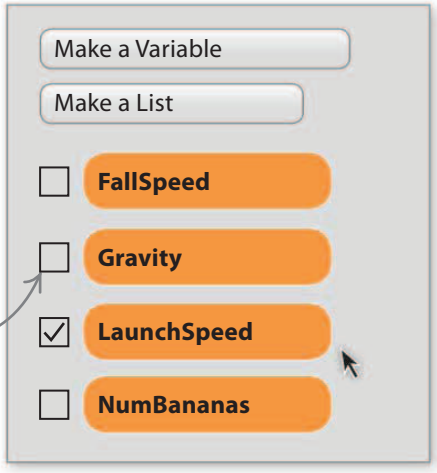
△ **Logic blocks**
Logical Operators blocks such as these three let you test for complex sets of conditions.

14 Make two more variables for all sprites: "FallSpeed" and "Gravity". Then add a "set Gravity" block to the monkey's "when clicked" script and amend his "when space key pressed" script as shown below. The new blocks use variables to simulate gravity. "FallSpeed" keeps track of how many steps the monkey needs to be moved down by gravity. The value of "Gravity" is how much "FallSpeed" increases each time the monkey moves.

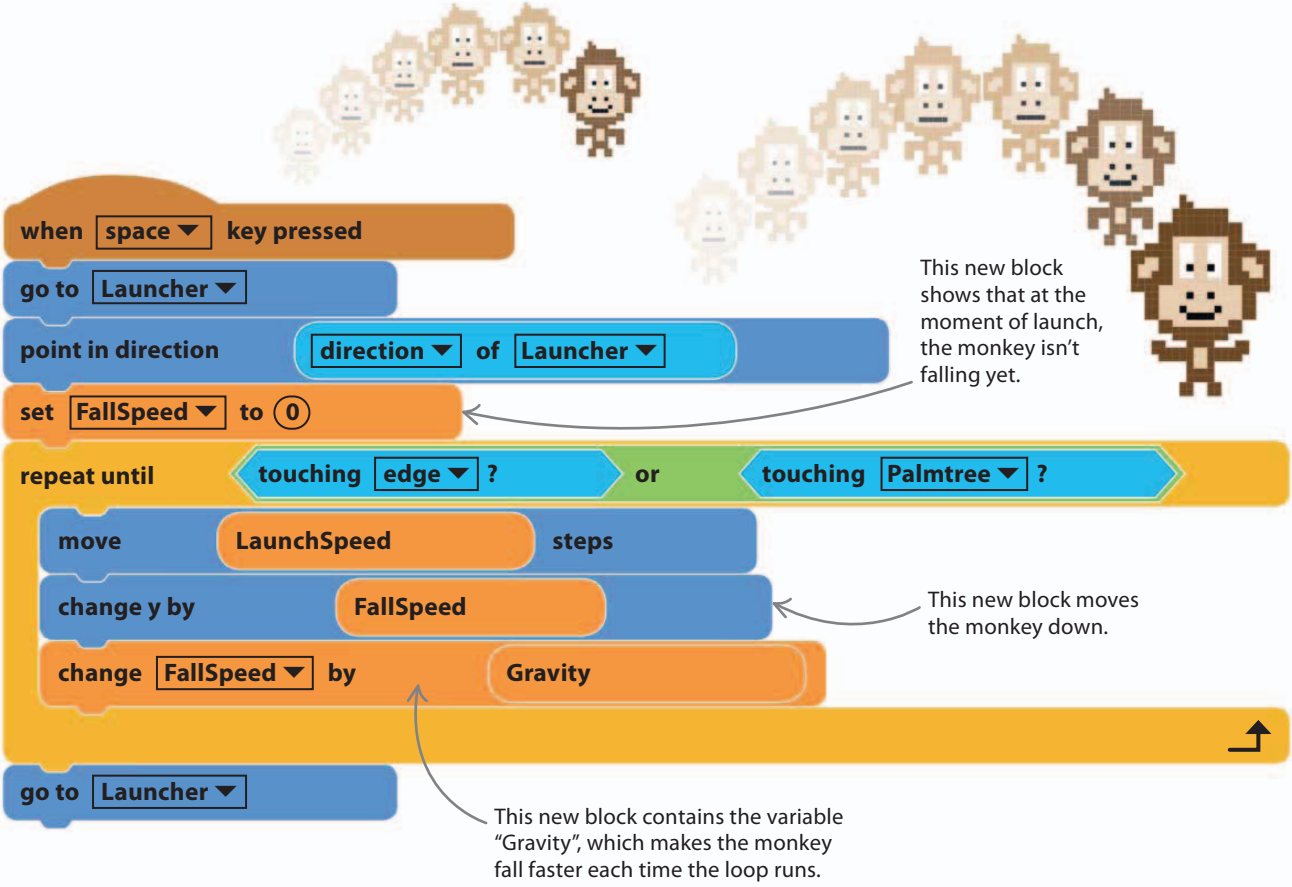


Add this block to the "when clicked" script.

Deselect the box next to a variable to stop it appearing on the stage.



△ **Hiding variables**
If you don't want variables to appear on the stage, you need to uncheck the box next to them in the Data section. Do this for these two new variables.



This new block shows that at the moment of launch, the monkey isn't falling yet.

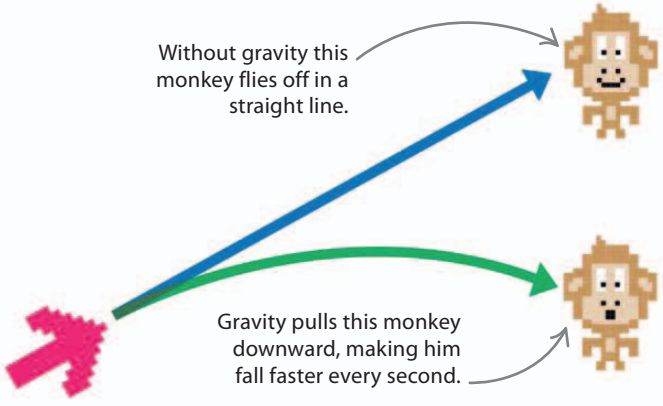
This new block moves the monkey down.

This new block contains the variable "Gravity", which makes the monkey fall faster each time the loop runs.

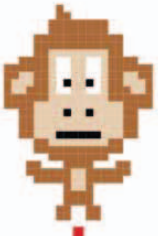
EXPERT TIPS

Real world gravity

In the real world, when you try to throw something in a straight line it curves slowly back toward the ground as gravity pulls it down. To make the game work in the same way, you move the monkey along the straight line, but also add a downward move after each shift along that line, to create the same effect as the constant downward tug of gravity. This allows the monkey's movement to seem natural, making the game more engaging.

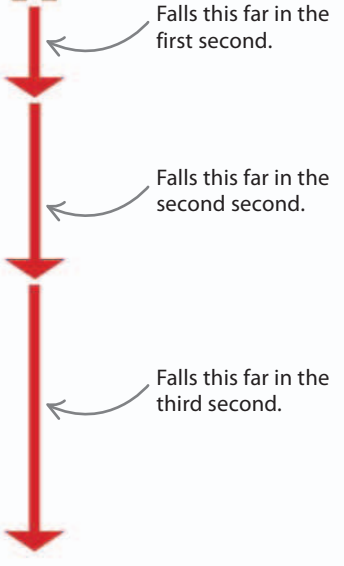


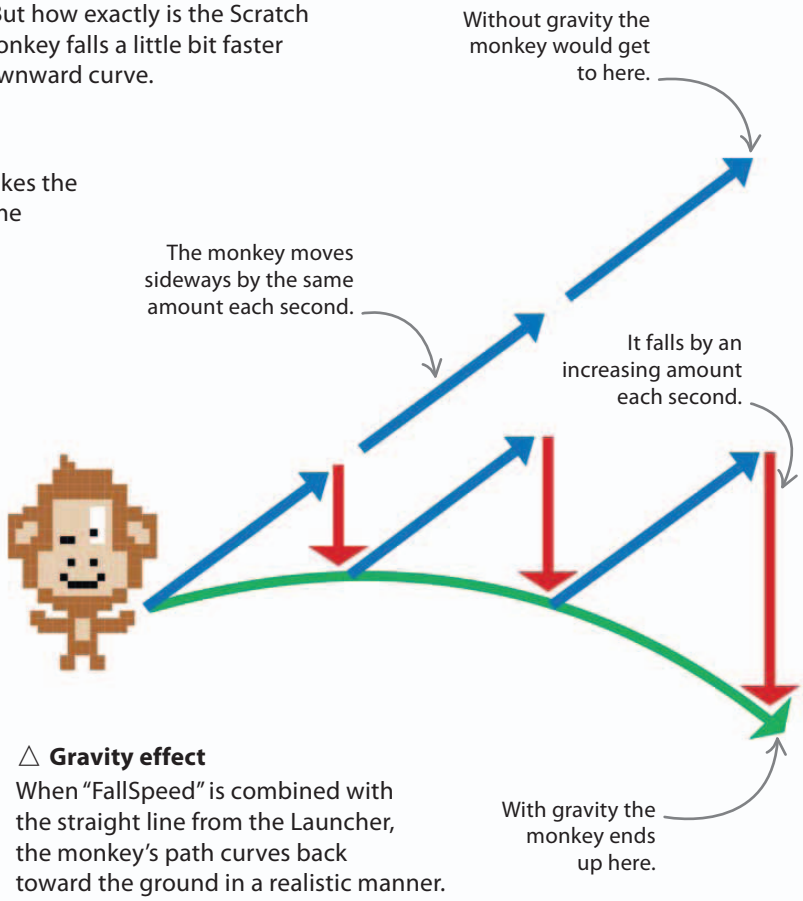
15 Run the project again—you can now direct the monkey over the tree to reach the tricky low bananas. But how exactly is the Scratch gravity working? Every second, the monkey falls a little bit faster than the second before, creating a downward curve.



◁ **Falling faster**

The "FallSpeed" variable makes the monkey fall farther each time the "repeat" loop runs.





△ **Gravity effect**

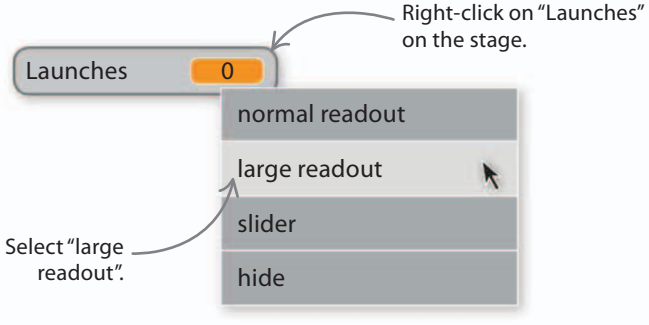
When "FallSpeed" is combined with the straight line from the Launcher, the monkey's path curves back toward the ground in a realistic manner.

Game over

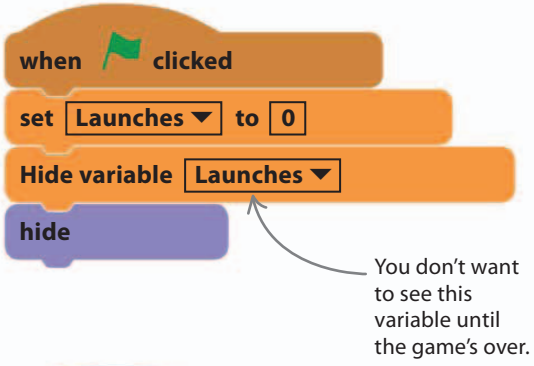
When the monkey has collected all the bananas, a "GameOver" message is broadcast, ending the game. Make a sign to go with it to tell the player how many launches were used to collect the bananas.

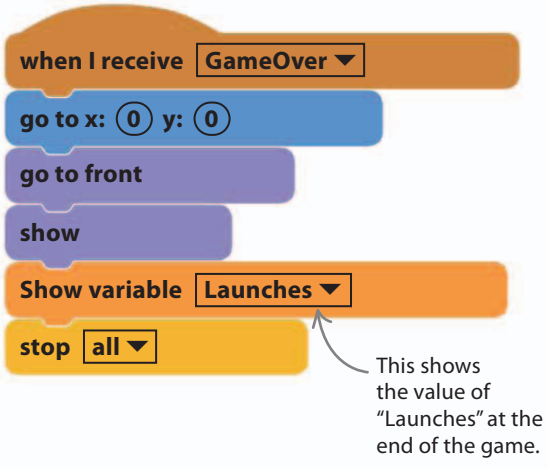
16 Click the paintbrush symbol to paint a new sprite and make a sign like the one below, leaving a gap in the text where the number of launches will go. You can make the sign as plain or as decorative as you like. Name the new sprite "GameOver".

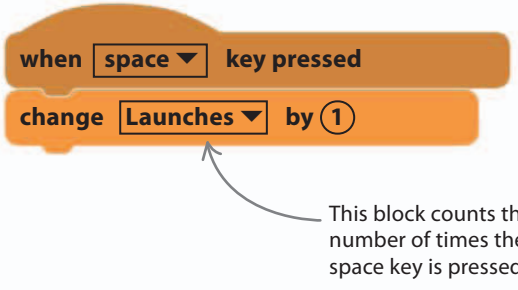
17 Now add a variable for all sprites to count the number of launches. Call this variable "Launches", show it on the stage, and right-click on it to change it to "large readout". This shows just the value and not the name of the variable. You'll reposition the launch counter later.



18 Now add these scripts to your sign. Together, they will count the number of times you launch the monkey and will display that number at the end of the game.

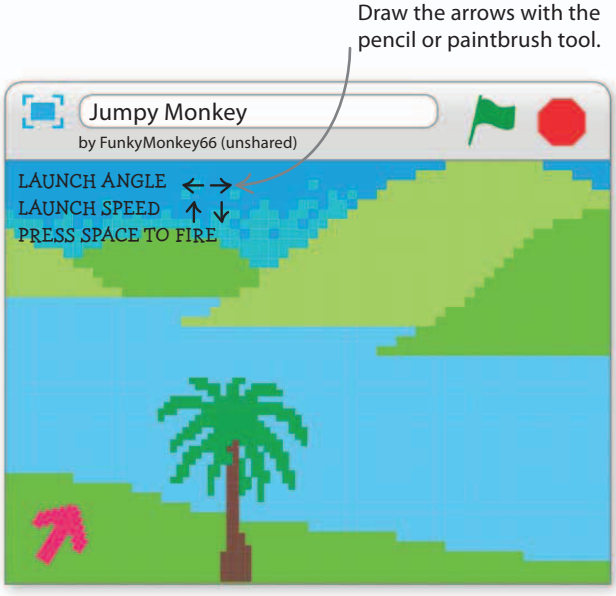






19 Run the game and collect all the bananas. When you see the "Game Over" sign on the stage, drag the "Launches" counter into the gap in the sign. Scratch will remember its position in future games, so the sign will always be in the right place.

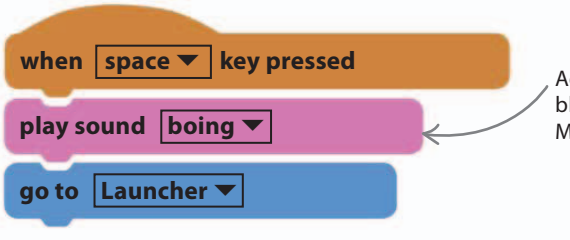
20 To add a backdrop, click on the stage information area in the bottom left and then choose the Backdrop tab at the top. Either paint your own scenery or load an image from the library. Use the text tool to add the game's instructions to the image, as shown below.



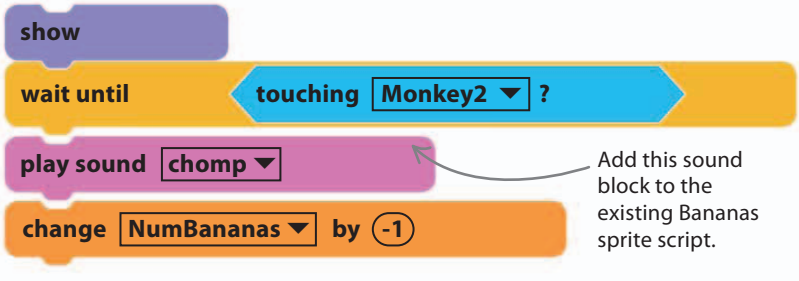
Make some noise

To make the game more interesting, you can add some sound effects. Follow the instructions below to play different sounds when the monkey is launched and when he eats the bananas.

21 Click the Monkey sprite, select the Sounds tab, and load "boing" from the library. Then add a "play sound" block to the existing monkey script in the position shown here. This will make the "boing" sound play every time the monkey jumps.



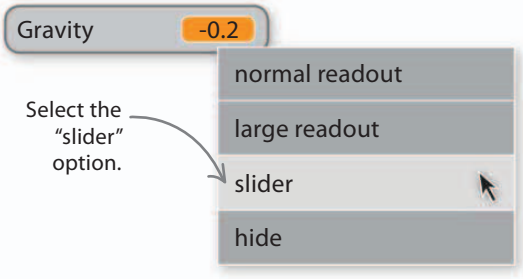
22 Click the Bananas sprite and load "chomp" from the sound library. Then add a "play sound" block to the existing banana script in the position shown here. Now the "chomping" sound will play each time the monkey gets a banana.



Playing with gravity

Add a slider to the game to allow you to experiment with the "Gravity" variable. The slider will allow you to tweak the "Gravity" value—you can even make the monkey fall upward.

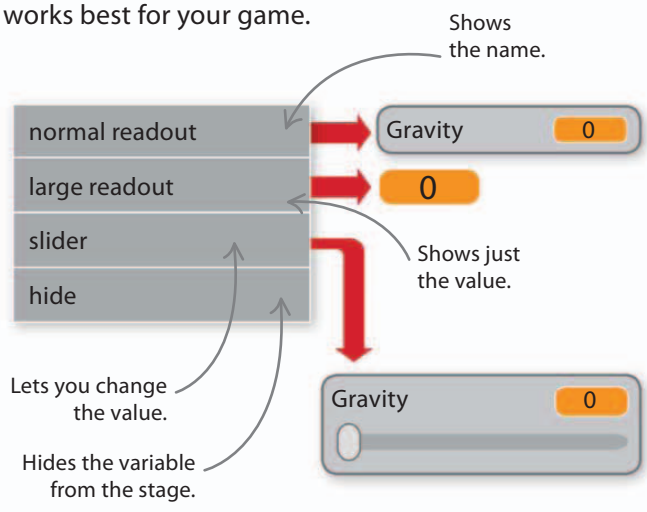
23 To adjust gravity in your game world, show the "Gravity" variable on the stage by checking its box in the Data section. Then right-click the variable display on the stage and select "slider". The slider lets you change the value of a variable on the stage.



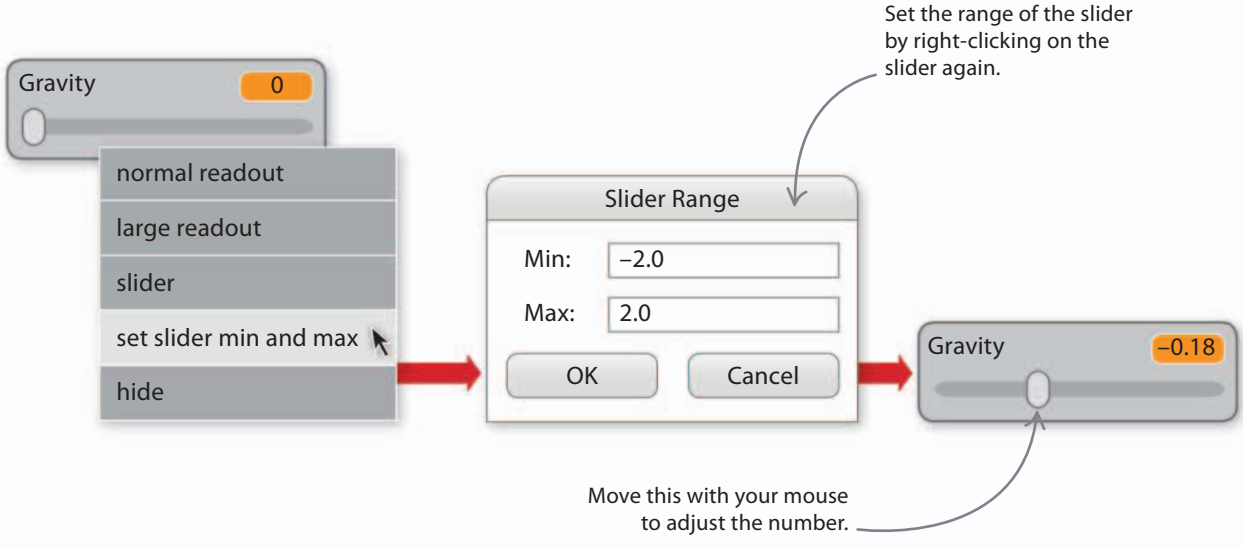
EXPERT TIPS

Displaying variables

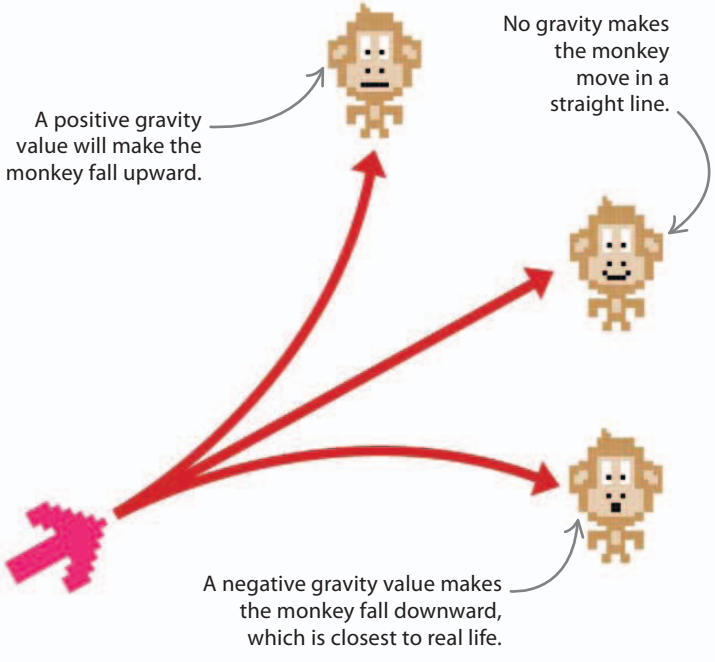
You can change how a variable is shown on the stage. There are three different options: normal readout, large readout, and slider. You can also hide the variable using this menu. Choose the look that works best for your game.



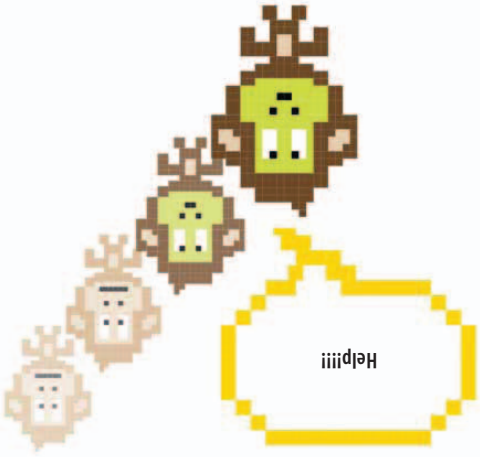
24 To set the range of the variable, right-click on the slider and type in the minimum and maximum values—for this game use –2.0 and 2.0. Make sure you type 2.0 not just 2, or the slider will only allow you to select whole numbers within the range.



25 Now play around with the gravity settings in this game using the slider. Using the suggested value of –0.2 works well, but take a look at what happens when you increase or decrease this number—if it is positive, the monkey will fall upward.



26 When you've finished experimenting with gravity, right-click on the slider and select "hide" to return the game to normal. Now you know how gravity works, you could try making a version of the game with reverse gravity so the monkey falls upward. Think about what changes you'd need to make to the game for this to work, like moving the Launcher to fire downward.



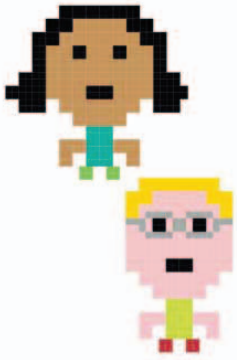
GAME DESIGN

Game physics

Physics is the science of forces and movement in the real world. Game physics is all about getting that science into games, so that things react and move around in realistic ways—being pulled down by gravity, for instance, or bouncing. Programmers have to solve all types of physics problems to make games more realistic or fun. When objects collide, should they bounce or crunch? How should objects move when they go underwater or into space?

△ **Defying gravity**
Game physics doesn't have to be like real-world physics—you can create worlds with gravity that makes things fall upward or even sideways. Gravity can be much stronger or weaker than in real life—perhaps balls fly higher with each bounce, until they shoot off into space.

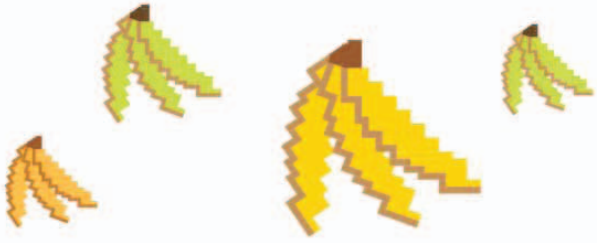
Hacks and tweaks



Congratulations—you've built your first game with gravity. Once you've tried the game a few times, you can start to play around with the code to make the game your own. Here are a few ideas to try out.

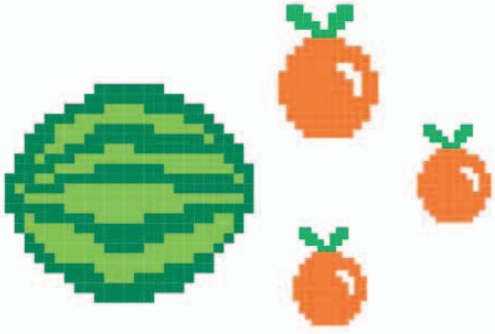
◁ Banana bonanza

Try adding more bananas, making then bigger or smaller, and put them in different places on the screen.



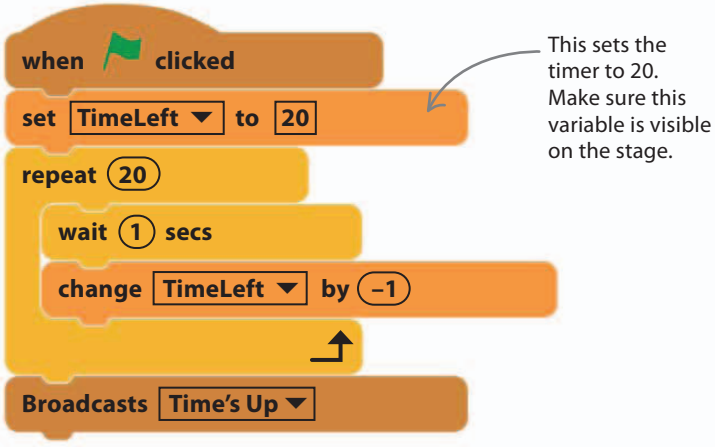
▽ Fruit salad

Add more fruits with a different score for each type. You'll need to make a "Score" variable and add extra sprites—there are oranges and watermelons in the Scratch sprite library.

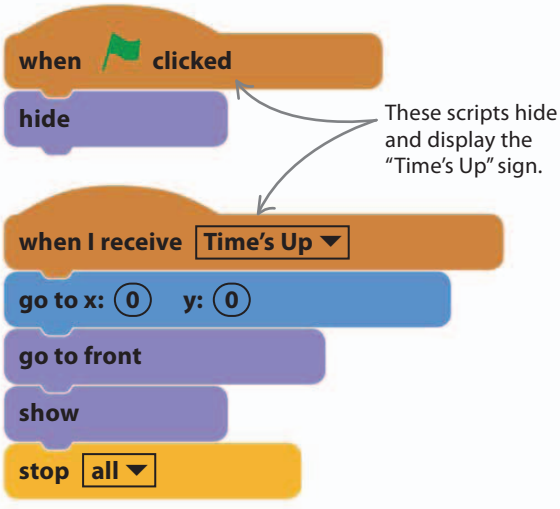


▽ Beat the clock

You can add a timer to make the player complete the game in a set time. Create a new variable called "TimeLeft" and add the script below to the Monkey2 sprite. Then create a new sprite, click on the Costumes tab, and make a sign that says "Times Up!" Finally, add the two scripts on the right to this sprite.



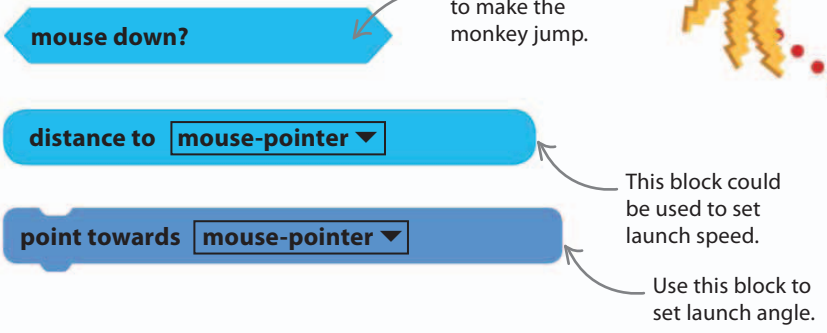
This sets the timer to 20. Make sure this variable is visible on the stage.



These scripts hide and display the "Time's Up" sign.

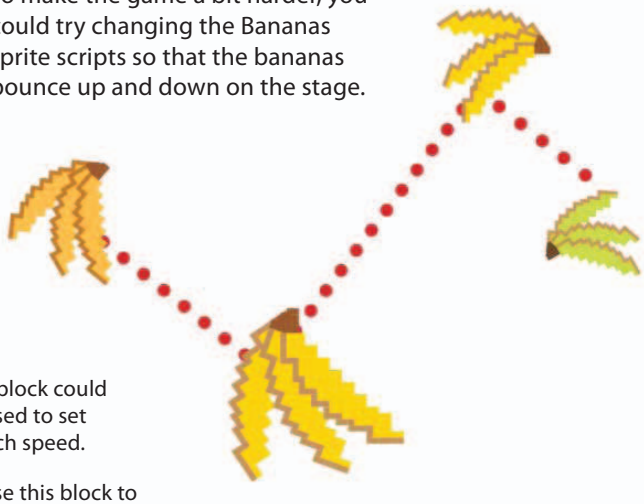
▽ Mouse control

You could use a computer mouse as the controller for this game instead of the keyboard. The three blocks below allow you to set the launch angle and speed as well as making the monkey jump. See if you can figure out some code to use them.



▷ Bouncing bananas

To make the game a bit harder, you could try changing the Bananas sprite scripts so that the bananas bounce up and down on the stage.

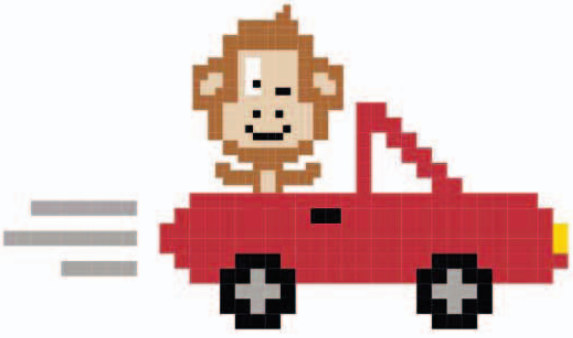


▷ Danger! Snake!

Add another challenge by creating an obstacle that gets in the monkey's way or maybe ends the game—perhaps a giant monkey-eating snake or spider?

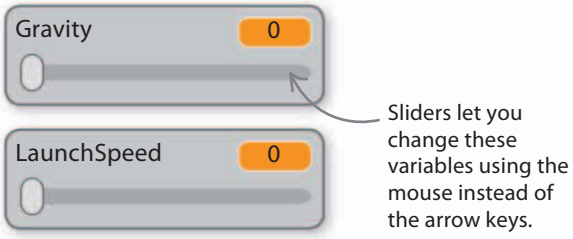
▽ Bug or bonus?

You might have discovered that you can adjust the monkey's speed in flight with the arrow keys. You can fix this by adding a new variable, "MonkeySpeed", and copying the value of "LaunchSpeed" into it at launch. Then use MonkeySpeed not LaunchSpeed in the move block for the monkey. Or, if you enjoy being able to change the monkey's speed, leave the game as it is.



▽ Launch speed slide

You've already tried adding a slider to control gravity. You could also add a slider to adjust launch speed.



Doom on the Broom

How to build Doom on the Broom

Games usually have a theme. This spooky game starts with bats swooping in on the player, followed by scary ghouls and monsters. Get ready to bring these sprites to life with animation.

AIM OF THE GAME

The witch is out riding her broomstick in the woods when creatures of the night begin to advance on her from all sides. She must cast her fireball spell to dispose of the bats, ghosts, ghouls, and dragons that have taken a fancy to her for dinner.

◁ **Witch**
The witch sits in the center of the screen. Spin her broomstick with the arrow keys and cast fireballs with the space bar.

◁ **Enemies**
Every enemy hit by a fireball is destroyed and a point is scored. As you win points, the game speeds up.

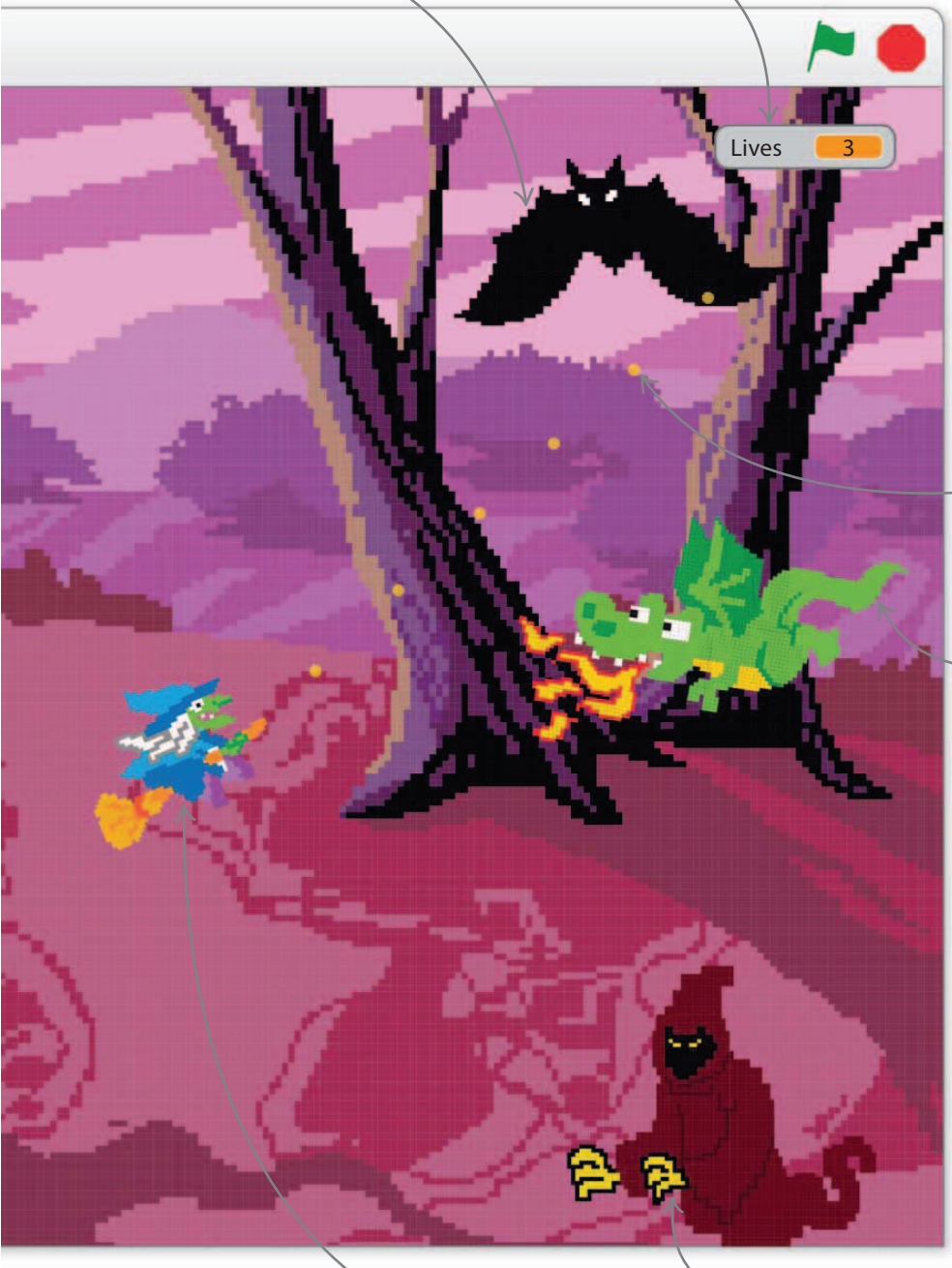
◁ **Lives**
The witch loses a life if she is touched by any of her enemies. But if a flying hippo touches her, she wins an extra life.

Slow-moving ghosts drift in and fade away when hit.

Superfast brown bats have a speedier attack.

Black bats flap straight toward the witch.

To make the game last longer, you can increase the number of lives.



Fireballs are the witch's only weapon.

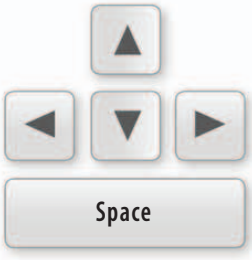
Fire-breathing dragons spiral in to catch the witch.

The witch stays in the center of the stage.

Like dragons, ghouls spiral in toward the witch.

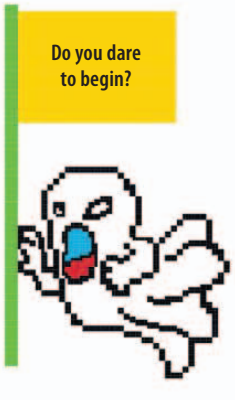
GAME CONTROLS

Use the arrow keys and the space bar on the keyboard as game controls.



◁ **Staying alive**

As the game progresses, more and more monsters fly toward the witch. The player must turn the broomstick quickly and pick off enemies one by one.



Setting the scene

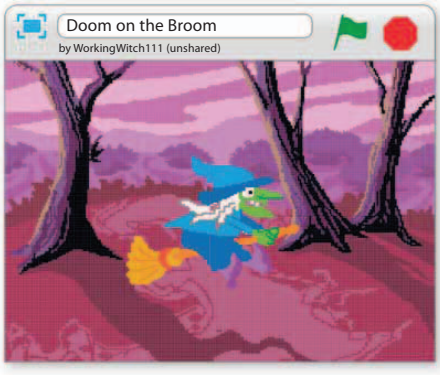
Doom on the Broom has a spooky theme. The sprites, backdrop, and music are all chosen to create a certain atmosphere that draws the player into the game world. Start by putting together the Witch sprite, a dark wood, and some creepy music.

1 Start a new project and call it Doom on the Broom. Delete the Cat sprite. Click the sprite symbol in the sprites list and choose the Witch sprite from the library.

Click to open the sprite library.

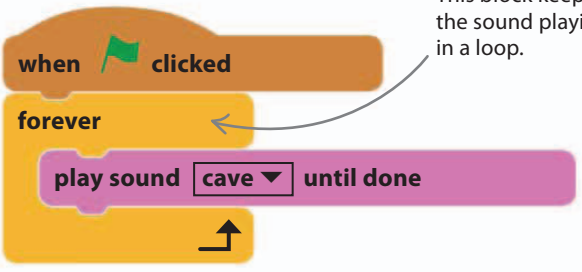
The Witch sprite will appear in your sprites list.

2 Click on the "Choose backdrop from library" symbol and add the backdrop "woods". This will lend an eerie setting to the game, which fits with the theme.



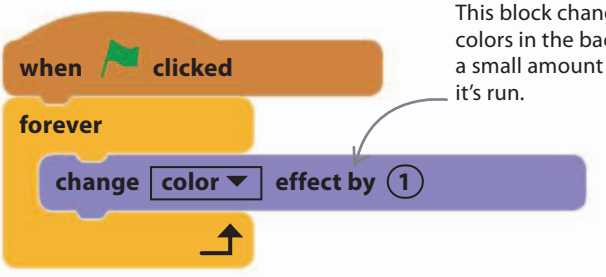
3 Load the sound "cave" from the sound library and add this script to the stage's scripts area. Run the project and admire the spooky atmosphere you've created.

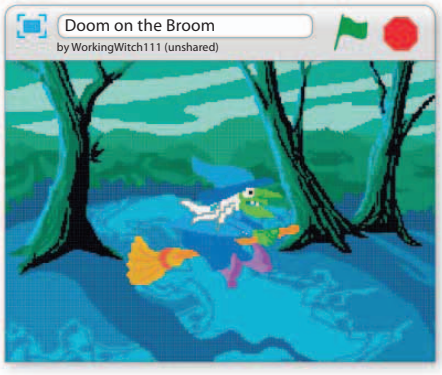
This block keeps the sound playing in a loop.



4 For extra creepiness, add another script to the stage to make it slowly but continually change color while the game is playing.

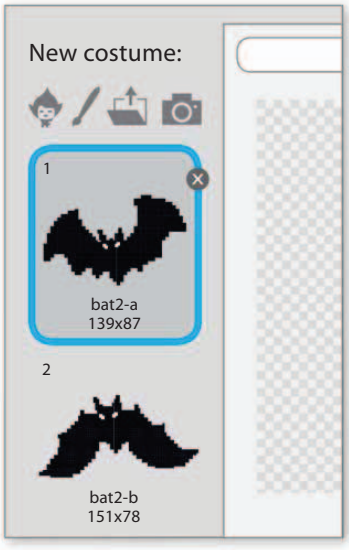
This block changes all the colors in the backdrop by a small amount each time it's run.



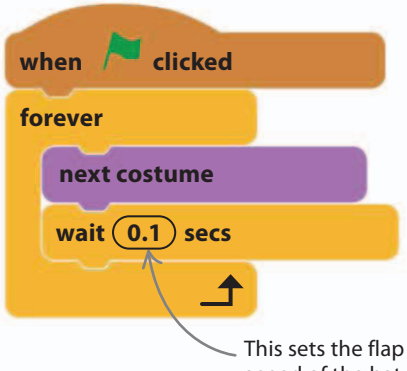


5 Now add the witch's first enemy: a sinister black bat. Open the sprite library, select Bat2, and click "OK".

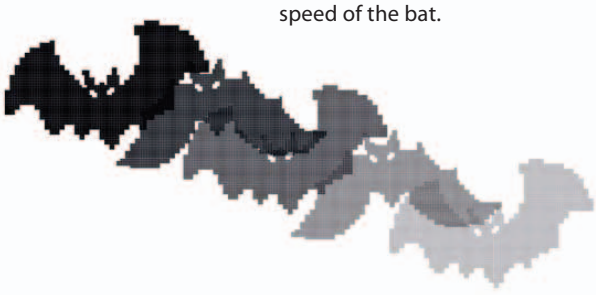
6 The bat looks scary but it doesn't move. Click the Costumes tab and look in the middle—you'll notice the bat has two different costumes. These two costumes can be used to make the bat flap its wings.



7 Add this script to the bat to make the costumes swap back and forth. Now run the project to see the bat flapping its wings.



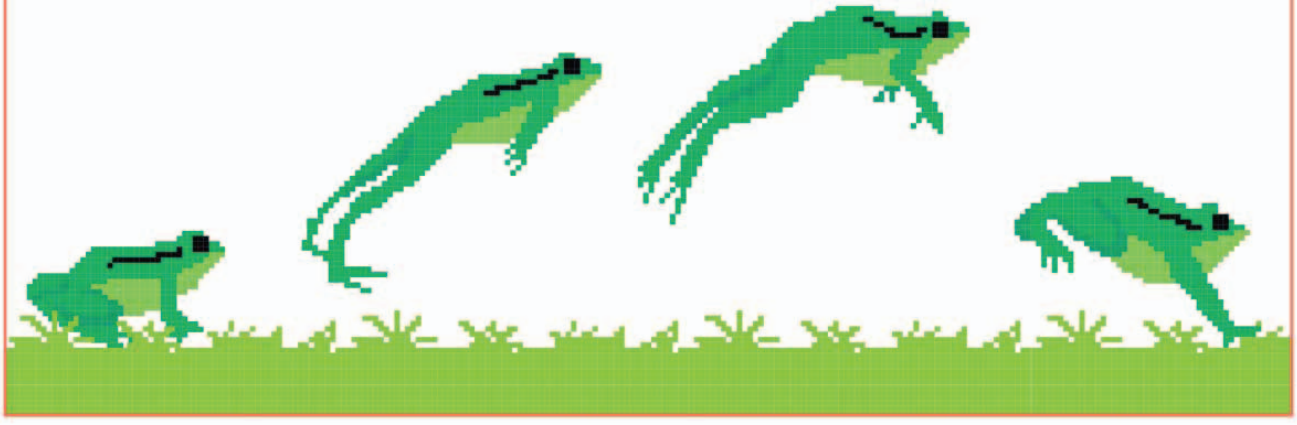
This sets the flap speed of the bat.



GAME DESIGN

Animation

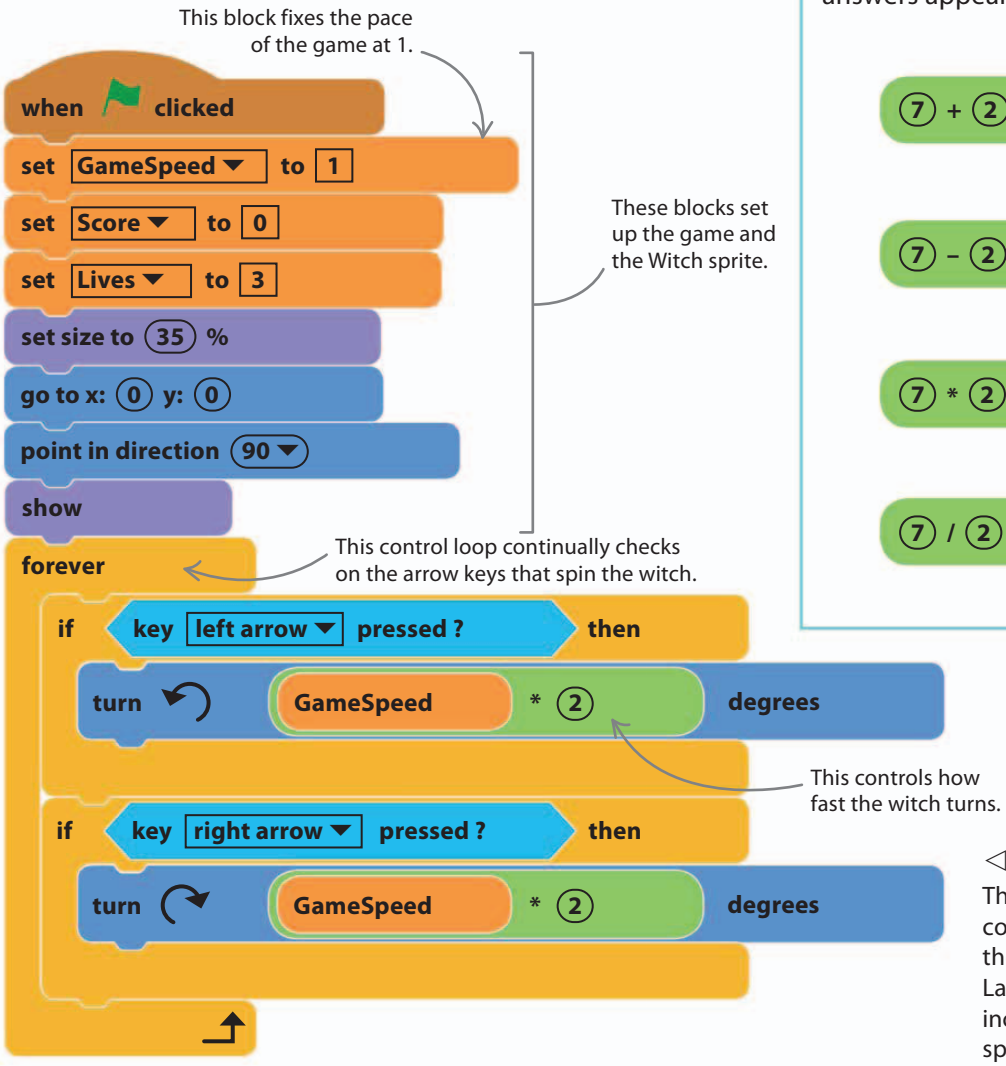
You can make pictures appear to move by showing slightly different versions of the same picture one after another. This fools the brain into thinking that it is a single moving image. This is called animation, and it is how all cartoons work. Scratch lets you animate a sprite by rapidly changing costumes that show it in different poses. When these costumes appear one after the other, you can see flapping bats, walking cats, and jumping frogs.



Controlling the witch

Your spooky game is now starting to take shape, but you'll need to add some more scripts to get things working. The next script lets the player take control of the witch.

8 Go to Data in the blocks palette and then click "Make a Variable". Create the variables "Score", "Lives", and "GameSpeed", making sure that the "For all sprites" option is selected. Show the variable "Score" and "Lives" on the stage. Add the following script to the witch to set things up and to control her with the arrow keys. Read the script carefully and test it to see if it works.

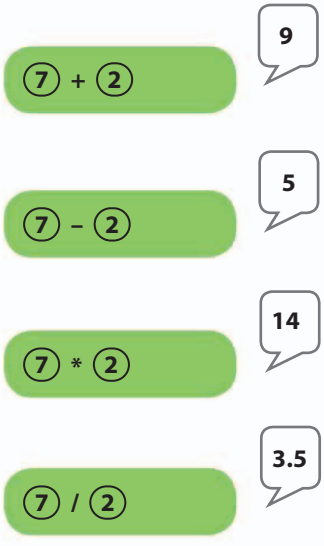


◁ **Controlling the pace**
The variable "GameSpeed" controls the overall pace of the game. For now fix it at 1. Later, you'll find out how to increase it as the score rises, speeding up the game.

EXPERT TIPS

Arithmetic operators

Computer programmers have to use special symbols to do math. Almost every computer language uses * for multiply and / for divide because the usual symbols aren't on a computer keyboard. Look in the green Operators section for the arithmetic operators. Click on the blocks in the scripts area to see the answers appear in a speech bubble.



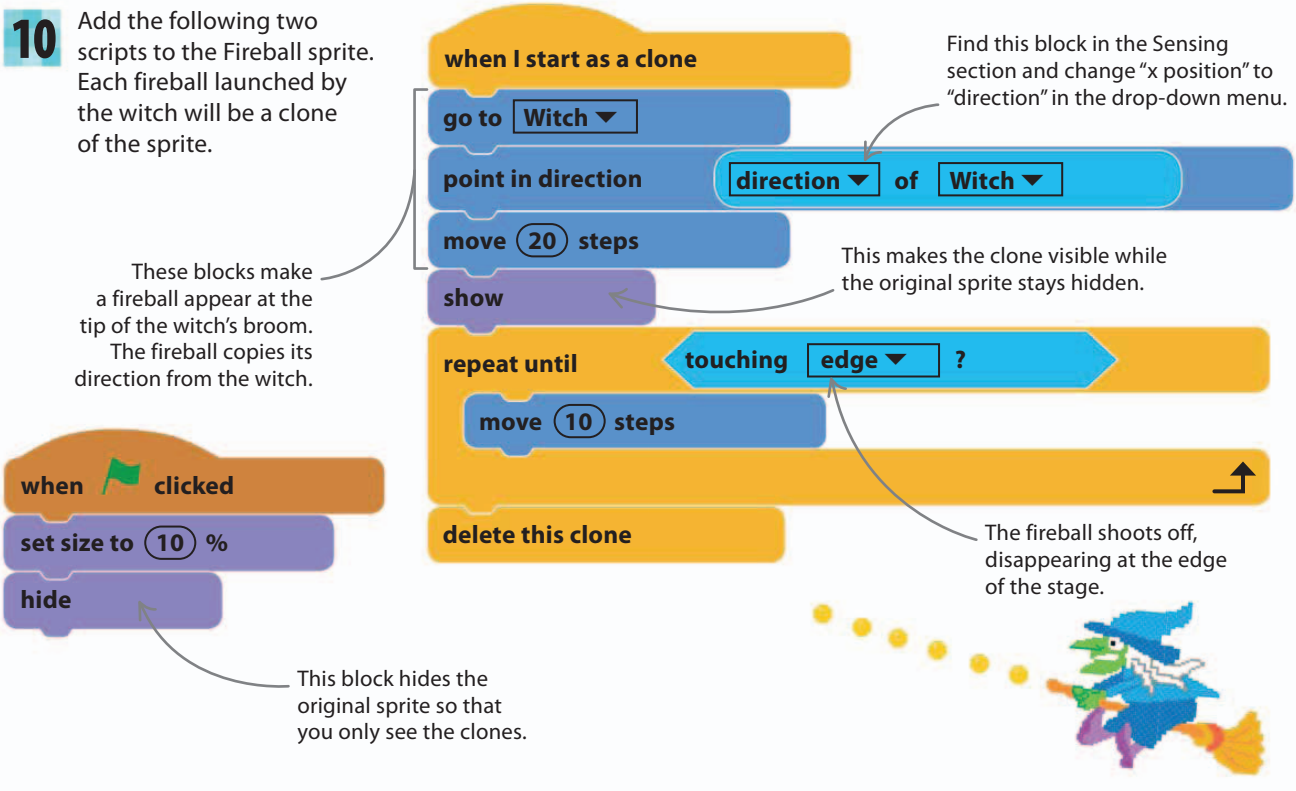
Casting fireballs

The witch's only defense against the rampaging spooks will be her fireball spell. The next script will make a fireball shoot from her broomstick when the player presses the space bar.

9 Add the Ball sprite from the library and rename it "Fireball". It's currently too big, but you'll shrink it down in a moment.

Click the blue "i" button to open the information panel and rename the sprite.

10 Add the following two scripts to the Fireball sprite. Each fireball launched by the witch will be a clone of the sprite.



Find this block in the Sensing section and change "x position" to "direction" in the drop-down menu.

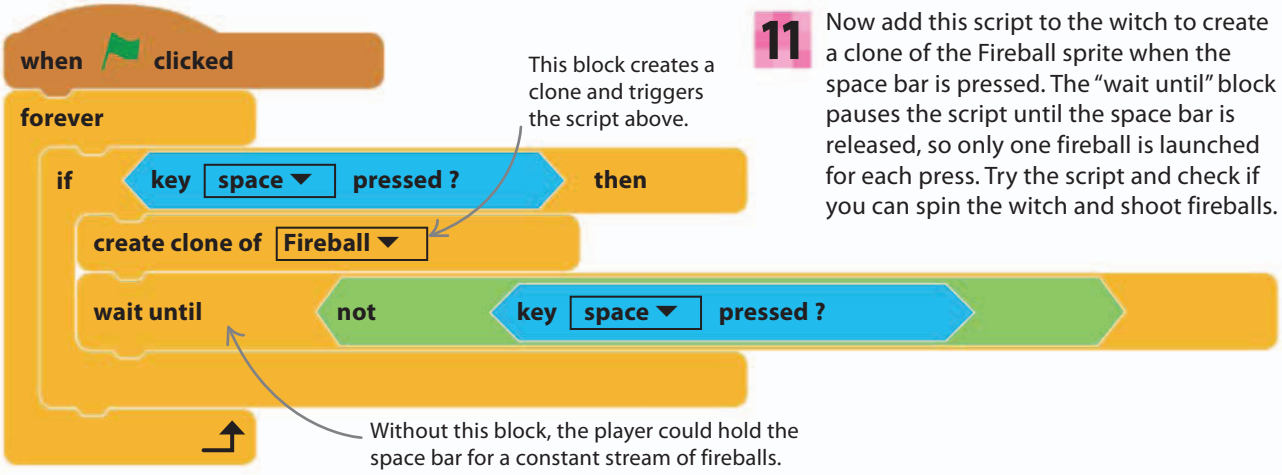
These blocks make a fireball appear at the tip of the witch's broom. The fireball copies its direction from the witch.

This makes the clone visible while the original sprite stays hidden.

The fireball shoots off, disappearing at the edge of the stage.

This block hides the original sprite so that you only see the clones.

11 Now add this script to the witch to create a clone of the Fireball sprite when the space bar is pressed. The "wait until" block pauses the script until the space bar is released, so only one fireball is launched for each press. Try the script and check if you can spin the witch and shoot fireballs.



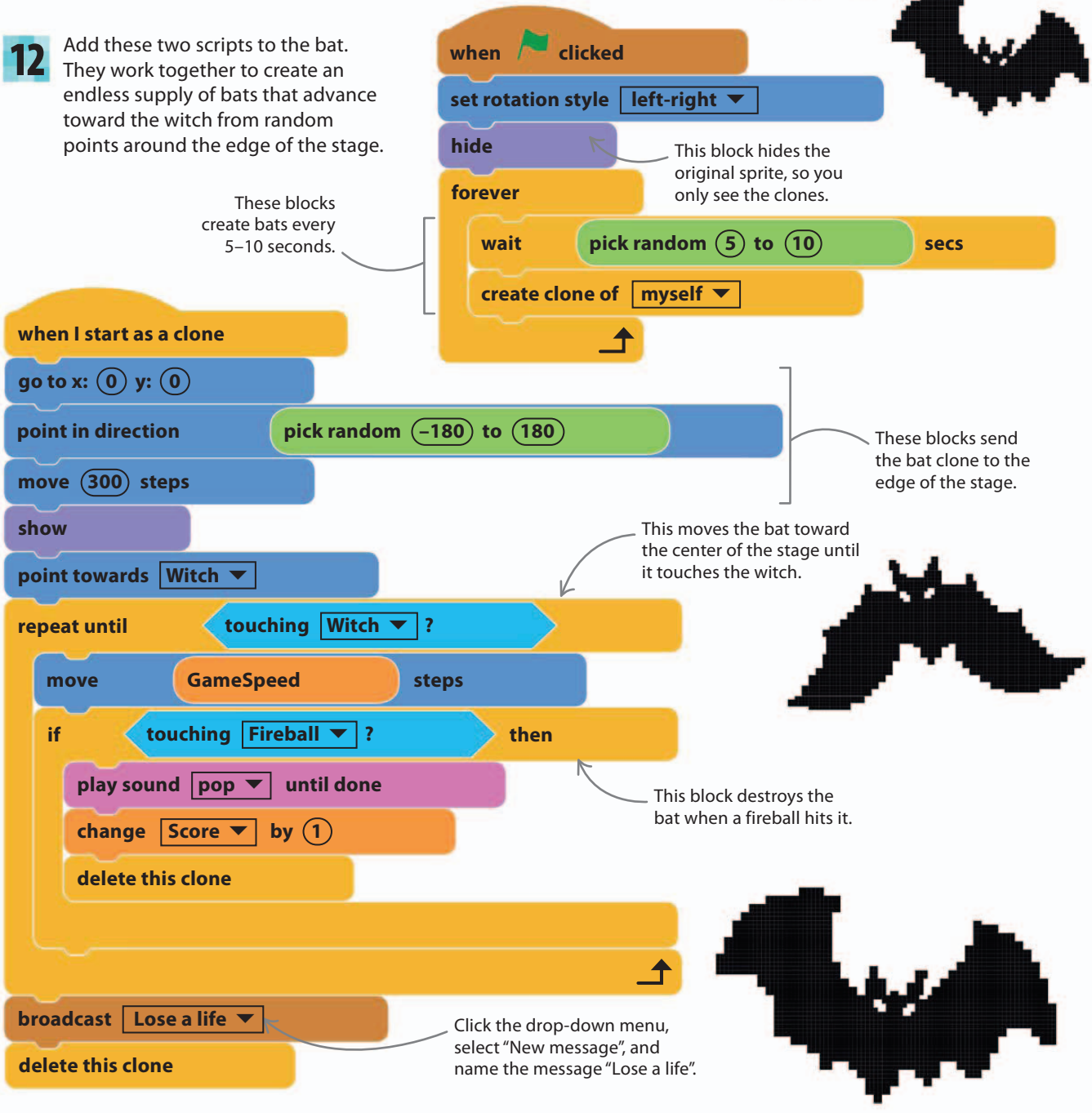
This block creates a clone and triggers the script above.

Without this block, the player could hold the space bar for a constant stream of fireballs.

Bat attack

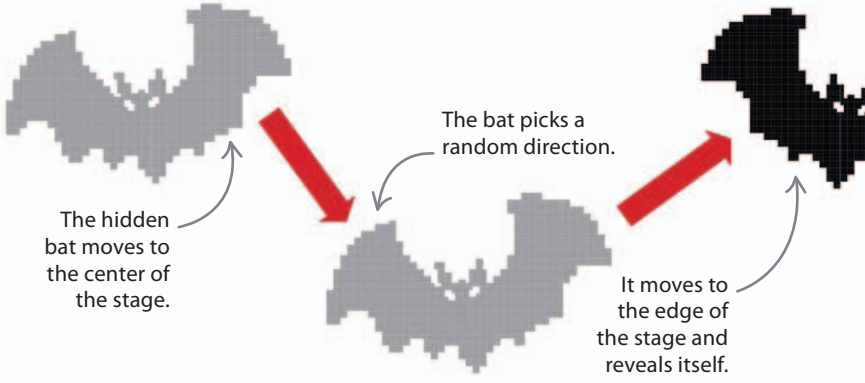
One flapping bat isn't going to scare a powerful spellcaster like the witch, but you can add clones to make a whole squadron of bats.

12 Add these two scripts to the bat. They work together to create an endless supply of bats that advance toward the witch from random points around the edge of the stage.



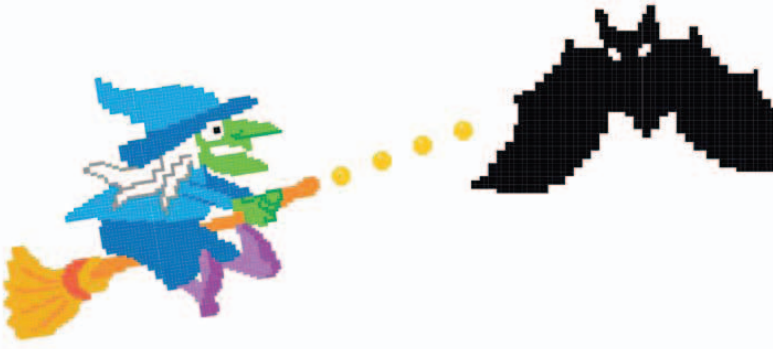
▷ How does it work?

The three blue Motion blocks at the start of the bat clone's script move the clone to a random point at the edge of the stage. The hidden clone first moves to the center and picks a random direction. Then it moves 300 steps—far enough to reach the edge in any direction. This way, bat clones will attack from every direction with equal chance. The witch doesn't touch the bat when it first moves to the center, because you can't touch a hidden sprite.

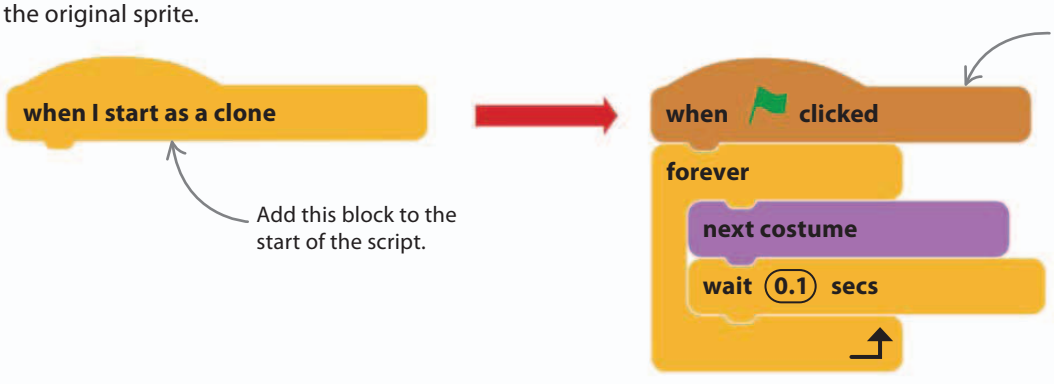


13 It's a good idea to remove all the bats whenever the witch loses a life. This gives her a chance to recover before the next wave of attackers. Add this script to the bat to do the job. When the message "Lose a life" is received, every clone runs the script and all the bats disappear.

14 Run the project to see if it works. A bat should appear after a few seconds and will move toward the witch. Soon more will appear. The witch should be able to use her fireballs to destroy them. All the bats will disappear when one finally reaches the witch.



15 You might notice that the bats aren't flapping anymore. To fix this, adjust the script below so that it runs for each clone rather than just the original sprite.



Adding explosions

Not much happens when the witch loses a life. Fix this to make the witch go out with a bang by creating some fireworks, adding a scream, and updating the counter that shows how many lives she has left.

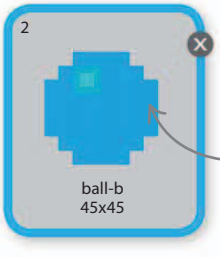
16 Add this script to the witch to make her react to losing a life. If she still has lives left, she will disappear for two seconds before returning to battle. If she's out of lives, then it's game over. Add a new message, "GameOver!", which you'll need later in the project. Now try the game again. The witch should lose lives and stop completely when the "Lives" variable has a value of 0.

Load "scream-female" from the sound library.

This makes the witch reappear after a pause if she has any lives left.

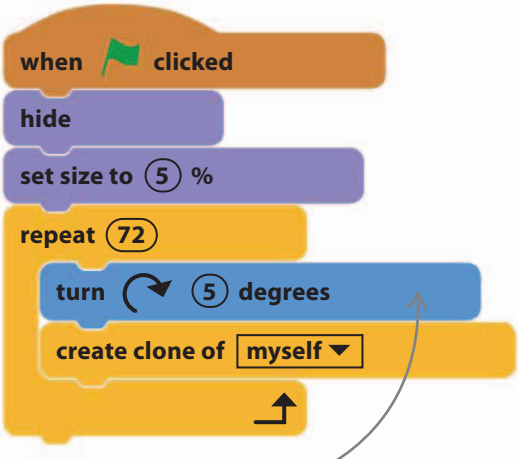
The "GameOver!" message will trigger a sign that you'll create later.

17 To create fireworks you need a new sprite. Load another Ball sprite from the sprite library rather than copying the Fireball sprite. Rename this new sprite "Explosion" and then click on the Costumes tab. Select the second costume so that the ball turns blue.

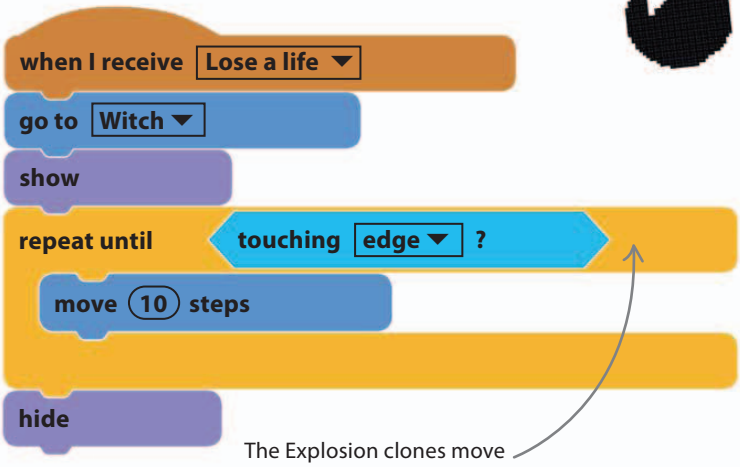


Select the second costume for the Ball sprite.

18 Now add these two scripts to the Explosion sprite. The first script creates 72 tiny, hidden blue ball clones, all pointing in different directions. The second script makes them fly out in a circle from the witch's location. Read the scripts carefully and try to work out what triggers the explosion.

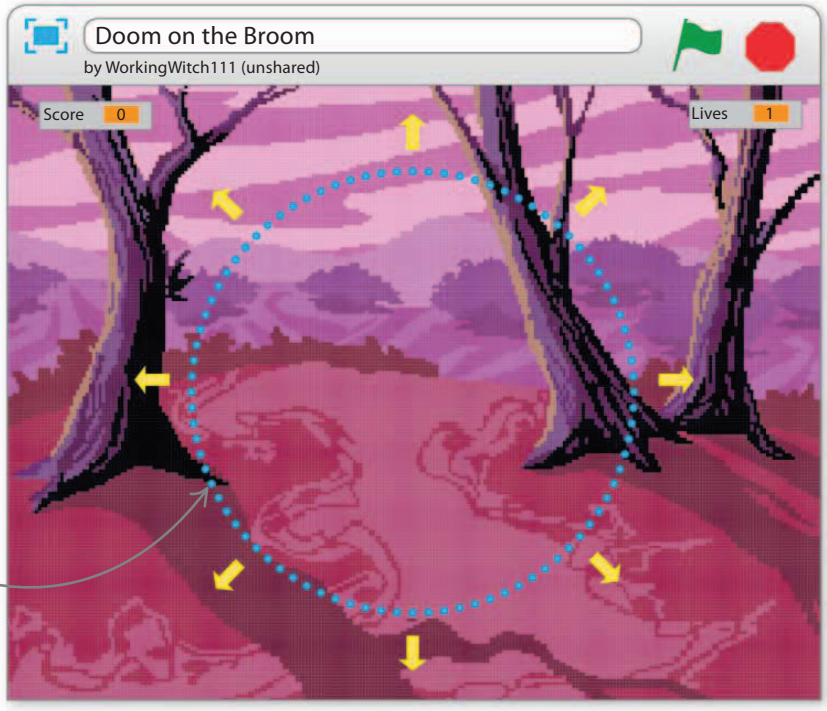


This makes each clone point in a different direction.



The Explosion clones move outward, disappearing at the edge of the stage.

19 When the Explosion sprite receives the message "Lose a life", all the blue ball clones appear at the witch's location and explode out to the edge of the stage before hiding once again. Run the game and let a bat reach the witch to check how it works.

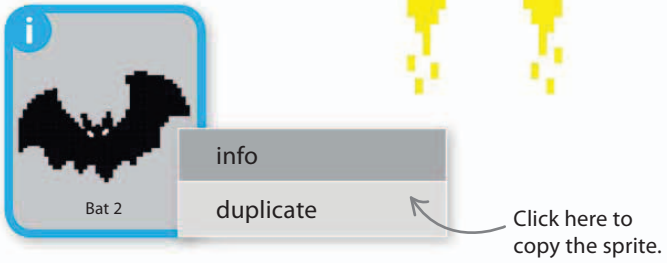


When a bat touches the witch, she explodes into a circle of flying blue balls.

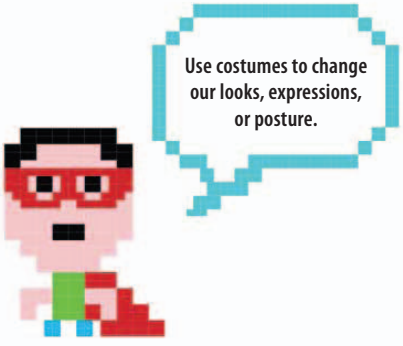
Speedy specter

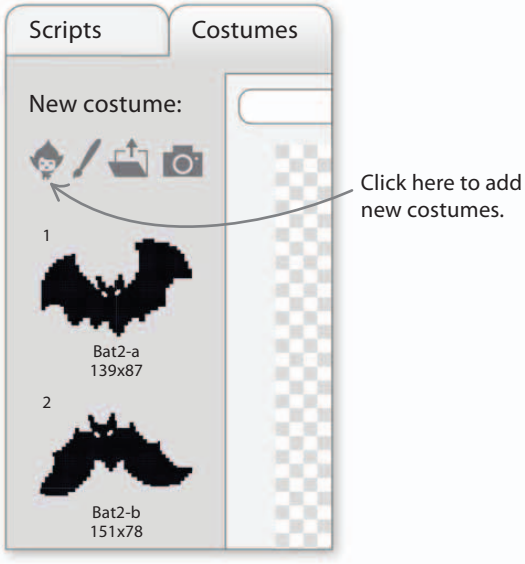
It's now time to increase the fear factor and add a different type of bat to the game. You can copy the existing black bat, and add new costumes and alter the scripts to create a superfast brown bat.

20 To avoid having to rebuild every script from the black bat, simply right-click it and create a copy by selecting "duplicate". A sprite named Bat3 will appear in the sprites list. Rename it "Fast bat".



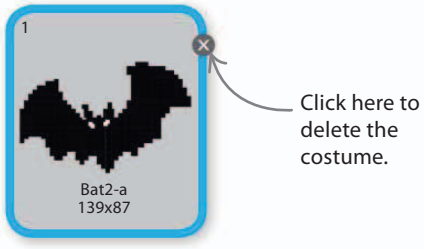
21 Click on Fast bat's Costumes tab—you'll see the copied black bat's two costumes. To make Fast bat look different from the black bat, you need to load some new costumes. Click on the symbol at the top to choose a new costume from the library.



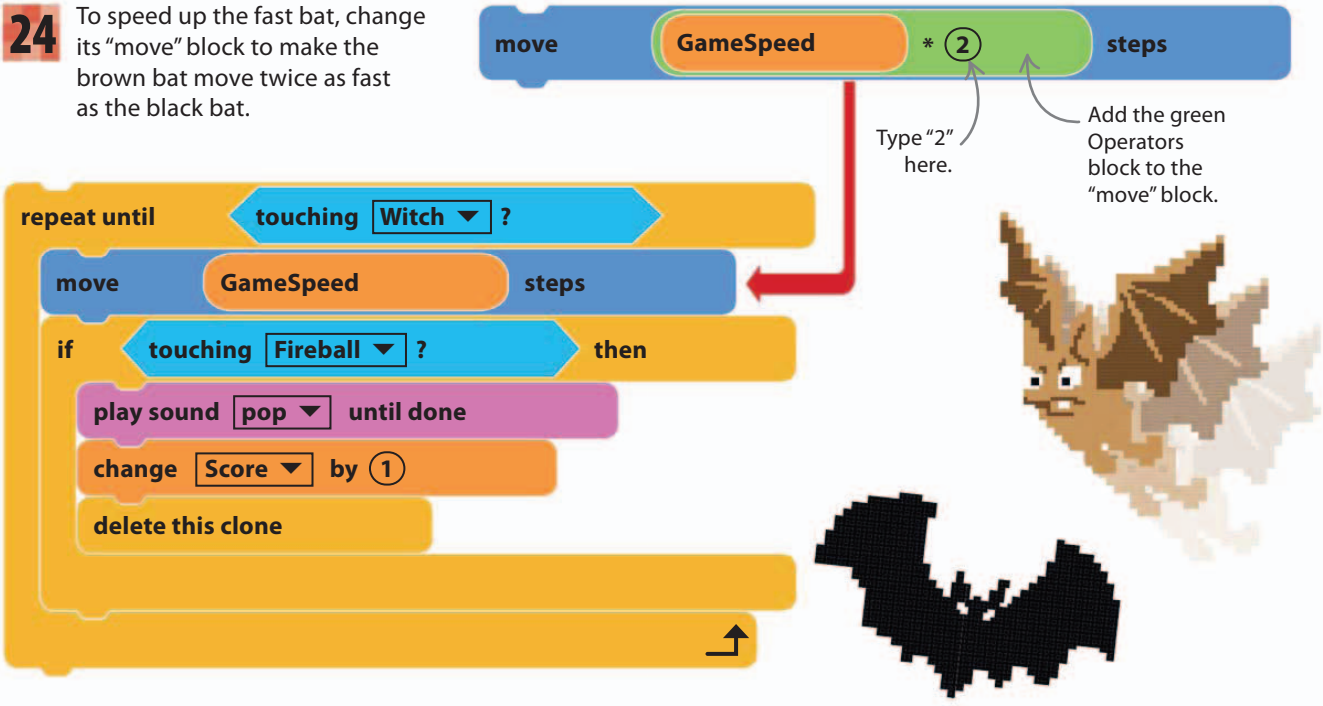


22 Add the two new costumes, "bat1-a" and "bat1-b". They show a brown bat with wings in two different positions.

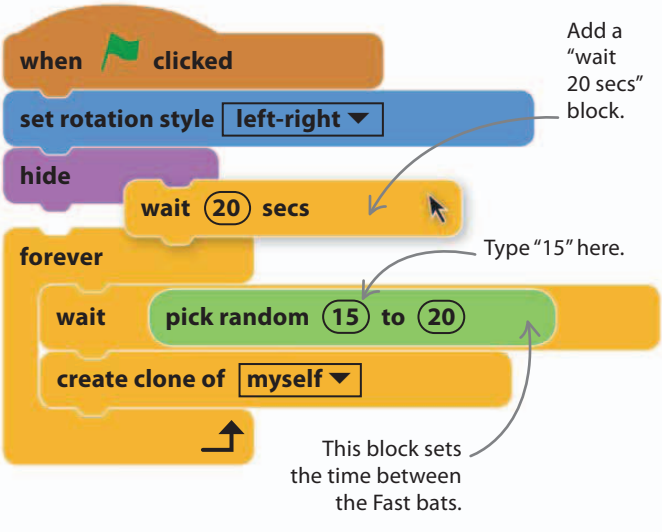
23 Now delete the unnecessary black bat costumes in this sprite. To do this, select the costume you want to delete and then click the small "x" in the top right.



24 To speed up the fast bat, change its "move" block to make the brown bat move twice as fast as the black bat.



25 The game would be too hard with lots of fast bats, so make the following changes to the existing script to make them appear later in the game and less frequently.



26 Check that you have four scripts in Fast bat's scripts area, just like in Bat2. Run the game. After a few black bats have attacked, a faster, much more dangerous one will appear, flapping away.

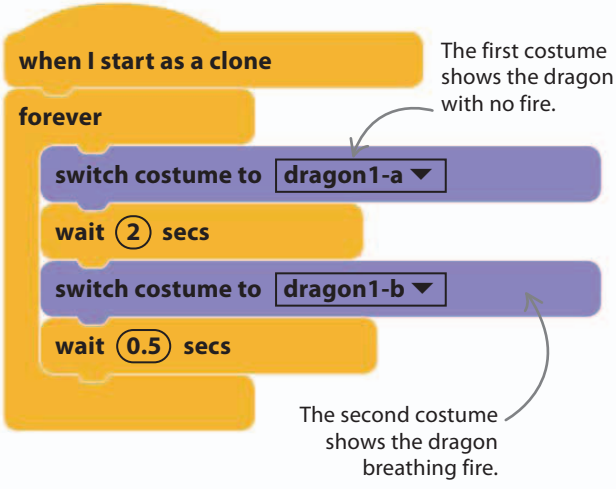
Fire-breathing dragon

The witch's next enemy is a fire-breathing dragon. Instead of flapping straight toward the witch as the bats do, it will spiral in slowly, which gives her more time to defend herself.

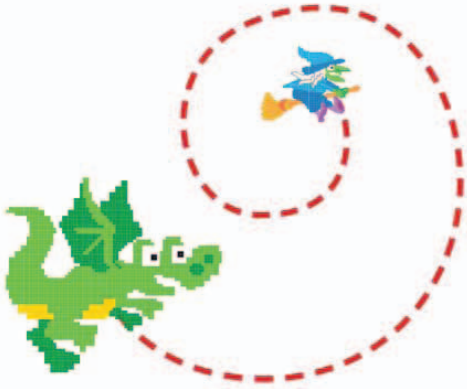
27 Copy the Bat2 sprite again, but rename it "Dragon". Load the two new costumes "dragon1-a" and "dragon1-b", then delete the two bat costumes.

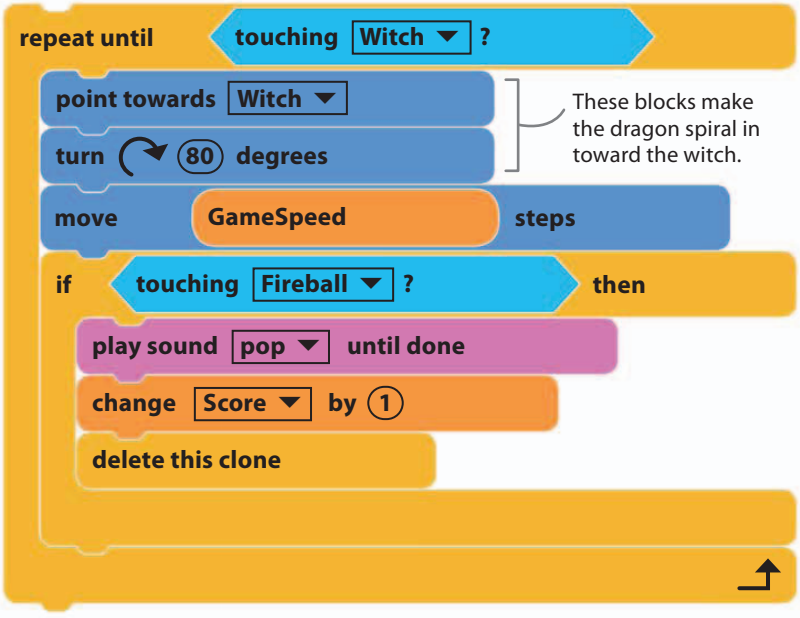
Type the new sprite's name here.

28 Now make a few changes to the scripts in the copied sprite. First, change the costume script to make the dragon breathe fire in short bursts.

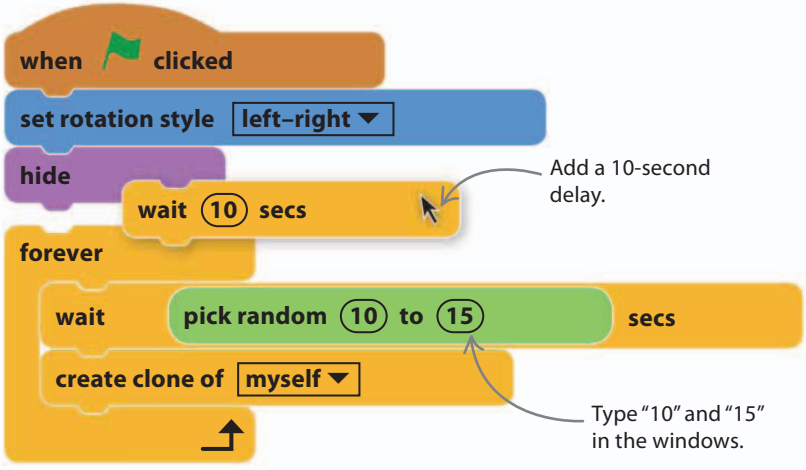


29 Next, modify the dragon's movement to make it fly in a spiral path by moving the "point towards Witch" block into the "repeat until" loop and adding a "turn right 80 degrees" block.





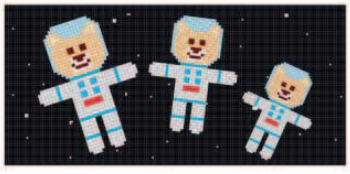
30 Add a "wait 10 secs" block to the main script to delay the dragon's arrival on the stage. Then change the numbers in the "pick random" block to "10" and "15". This will make a clone of the dragon appear every 10–15 seconds. Once you've made all the changes, test the game to see if it works.



GAME DESIGN

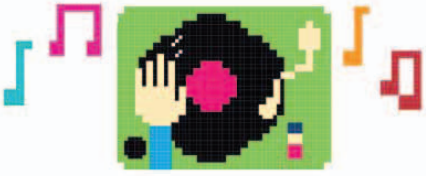
Working with themes

In Doom on the Broom, spooky scenery and supernatural characters work together to give the game a theme. A strong theme that ties together the elements of a game can make it feel polished and professional. Working with themes is also great fun because you can let your imagination run wild.



△ **Story**

A background story or quest helps give a game a theme. Perhaps the player is trying to escape a haunted house, search for underwater treasure, or explore an alien planet. Instead of inventing a story, you can use a well-known one, but give it a twist, such as putting Goldilocks and the three bears in space.



△ **Music and sound effects**

Sounds in a game have a big influence on how the player feels. Spooky music makes the player nervous, but happy music makes a game feel cheerful, even if the pictures are spooky. Choose sound effects carefully so they match the sprite or situation that triggers them.

△ **Scenery**

If you choose the right backdrop, sprites in the game will look like they are really there rather than stuck on top. You can create your own backdrops in Scratch's paint editor, but you can also upload images you've found or created elsewhere.

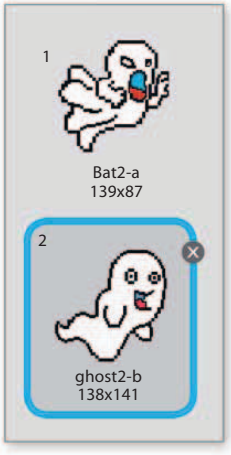
△ **Sprites**

The player is usually the hero in a game, so choose a likable sprite. The enemies don't have to look scary—even cute sprites can seem scary when they attack. If players have to collect objects, make them look valuable, such as coins or gems.

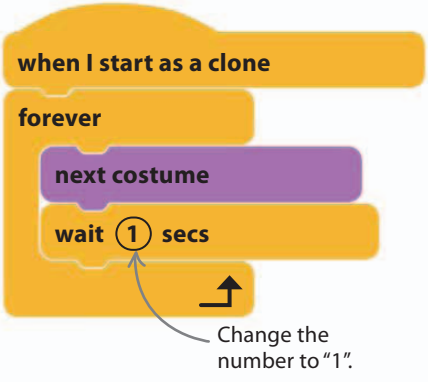
Ghost

Supernatural heroes should have supernatural enemies, so add some ghosts and ghouls to chase the witch. Instead of vanishing when fireballs hit them, the ghosts will fade away.

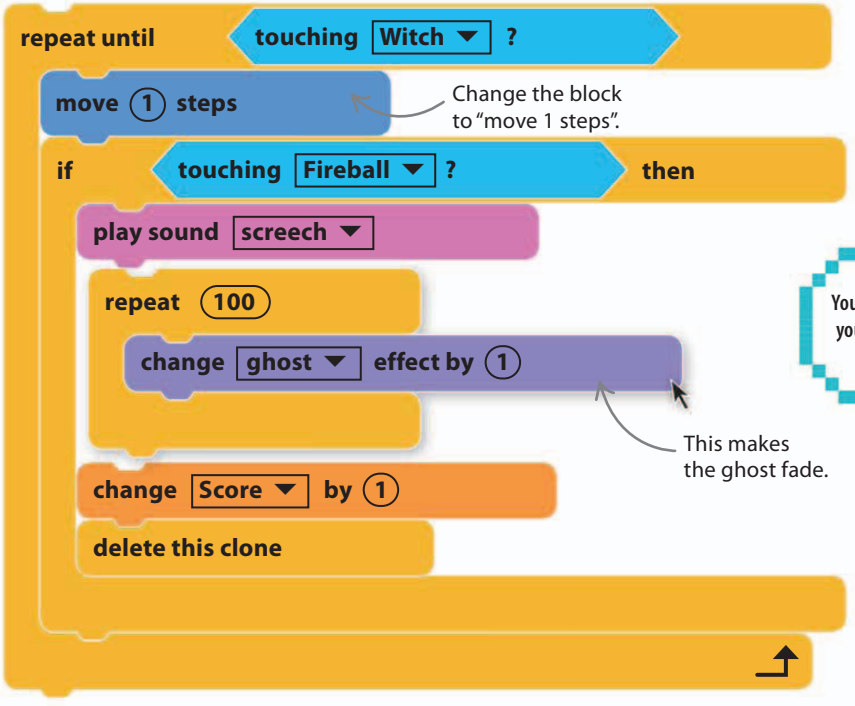
31 To create the ghost, make a copy of the Bat2 sprite again. Rename the new sprite "Ghost" and replace the Bat2 costumes with "ghost2-a" and "ghost2-b".



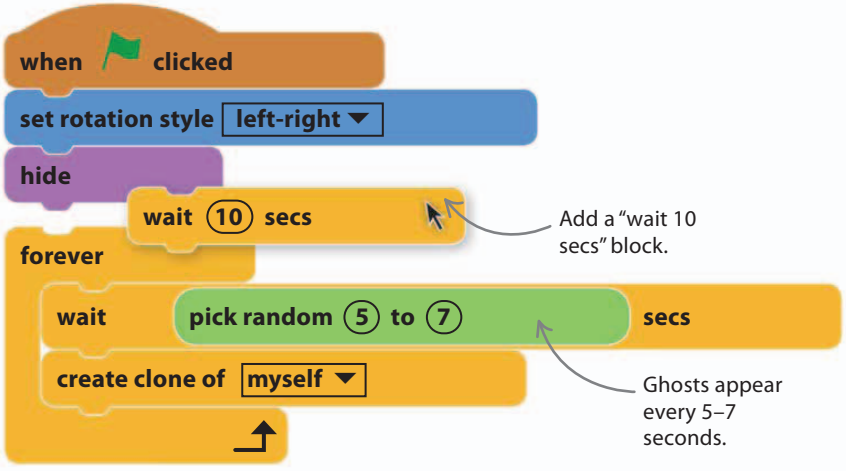
32 Modify the script below so the costumes change every second.



33 Change the ghost's script so that it moves slowly and fades out when hit by a fireball. Click the Sounds tab above the blocks palette and load the "screech" sound from the sound library. Then change the selection in the "play sound" block to "screech" to make the ghost scream when it vanishes.

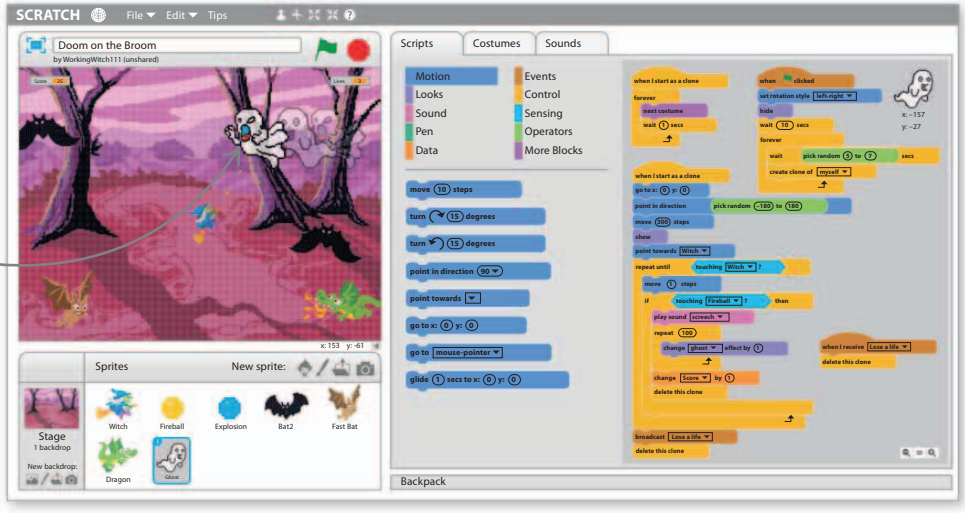


34 Now add a "wait 10 secs" block to the main script to delay the ghost's first appearance. Change the numbers in the "pick random" block to make ghosts appear more often than bats.



35 Once all of your changes are complete, test the game. Try fireballing each enemy to make sure the code works.

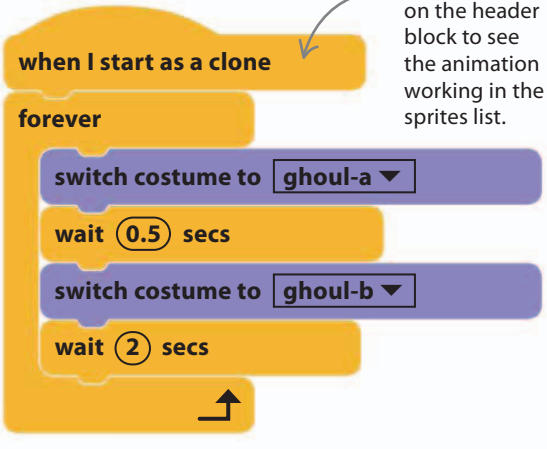
The ghost should slowly fade when hit with a fireball.



36 The Scratch library has two ghoul costumes that you can use to make another animated enemy. Copy the Dragon sprite and rename the copy "Ghoul". Click the Costumes tab, load the two ghoul costumes—"ghoul-a" and "ghoul-b"—and then delete the dragon's costumes. Update the ghoul's script to use the new costumes and adjust the timings.

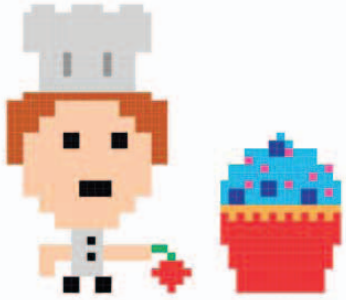

ghoul-a


ghoul-b

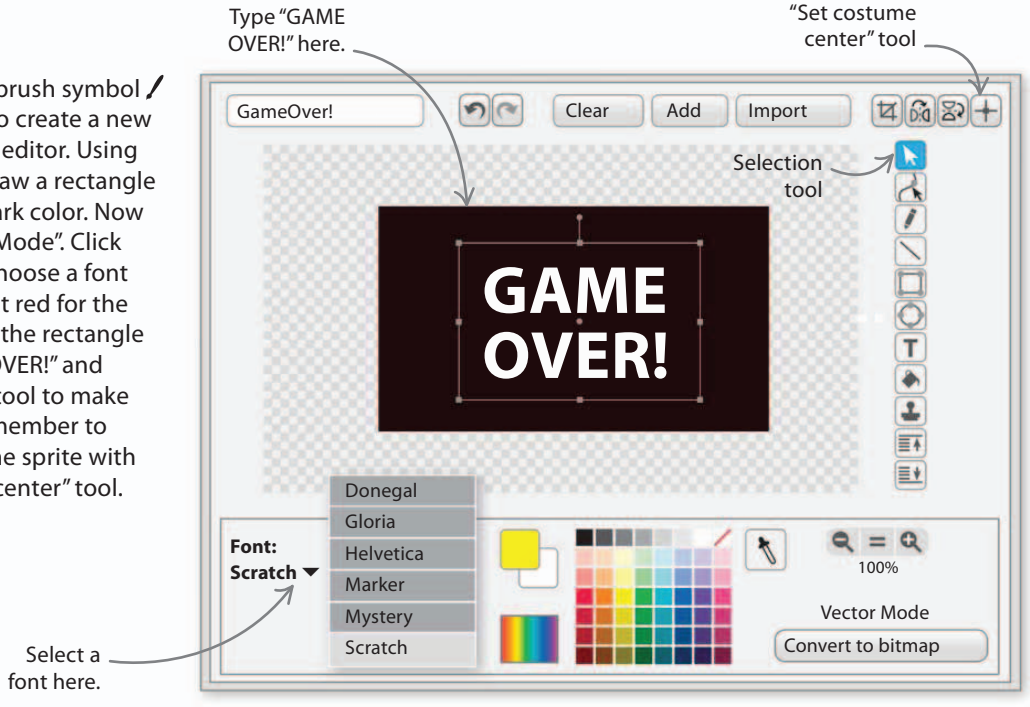


Finishing touches

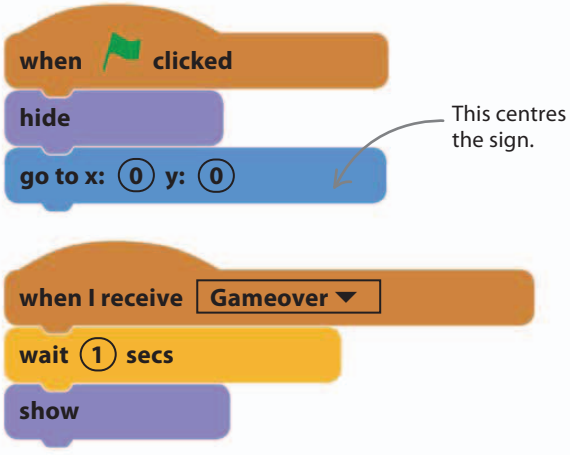
It's time to add some finishing touches to the game. To make it look more professional, add a "Game Over!" screen that appears when the witch runs out of lives. You can also program the witch to give instructions to the players at the start of the game.



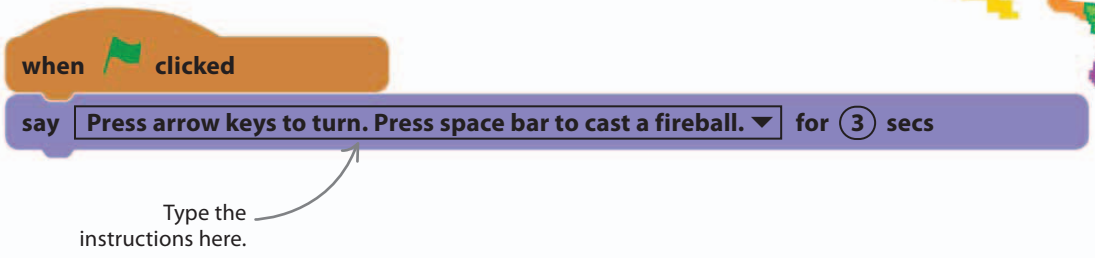
37 Click on the paintbrush symbol in the sprites list to create a new sprite in the paint editor. Using "Bitmap Mode", draw a rectangle and fill it with a dark color. Now switch to "Vector Mode". Click on the text tool, choose a font you like, and select red for the text color. Click in the rectangle and type "GAME OVER!" and use the selection tool to make the text large. Remember to fix the center of the sprite with the "Set costume center" tool.



38 Now add these scripts to the Game Over sprite to hide it at the start and show it only at the end when the witch loses all her lives. Run the game. Once the witch loses all her lives, the message will be displayed on the stage.



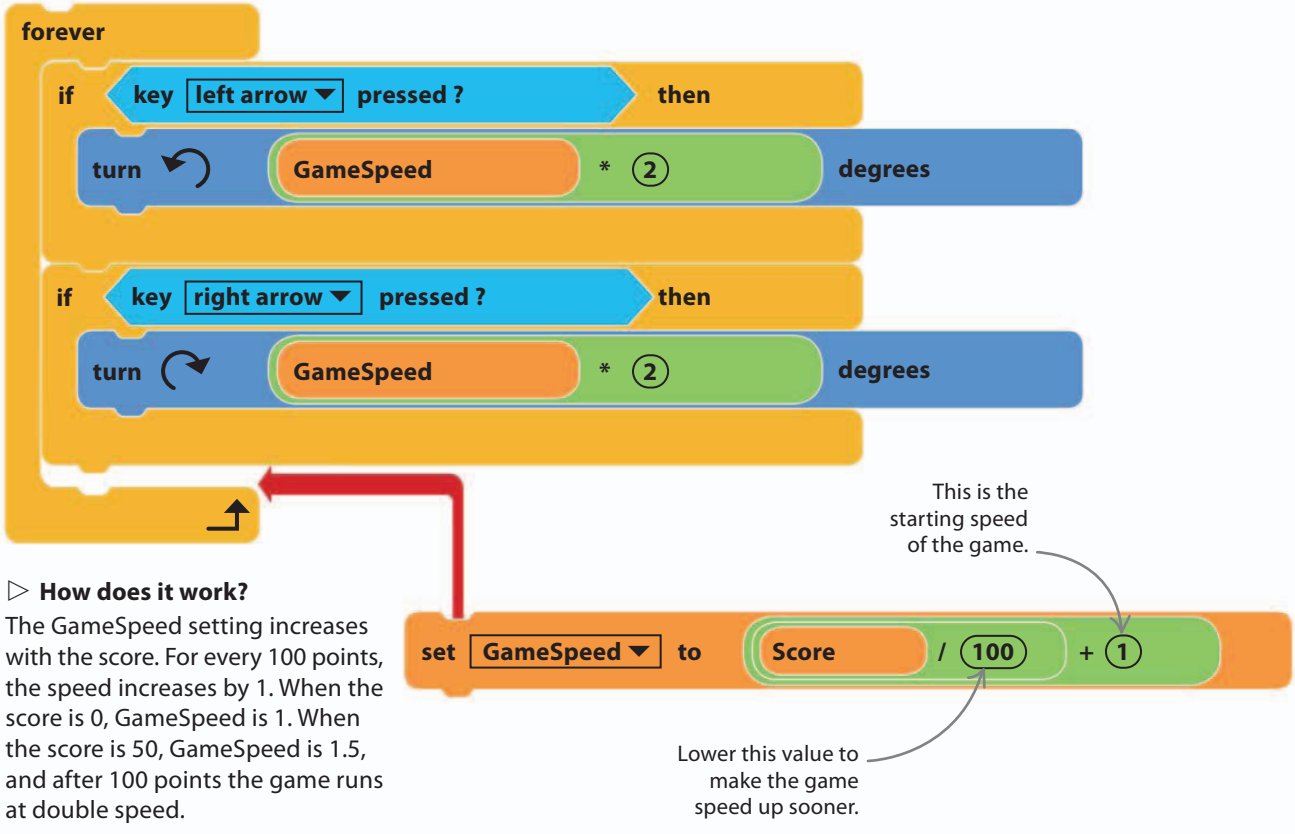
39 Add a script to the witch so that she gives instructions to the player at the start of the game. You can change the three seconds in the "say" block if it's too quick, but not for too long—those bats won't wait.



Challenger mode

As players become more skilled and score more points, they may start to get bored with the game. You can prevent this by making the game faster as it progresses.

40 To make the game speed up as the player scores points, add a block inside the witch's movement loop that sets the "GameSpeed" variable using the variable "Score".



▷ **How does it work?**

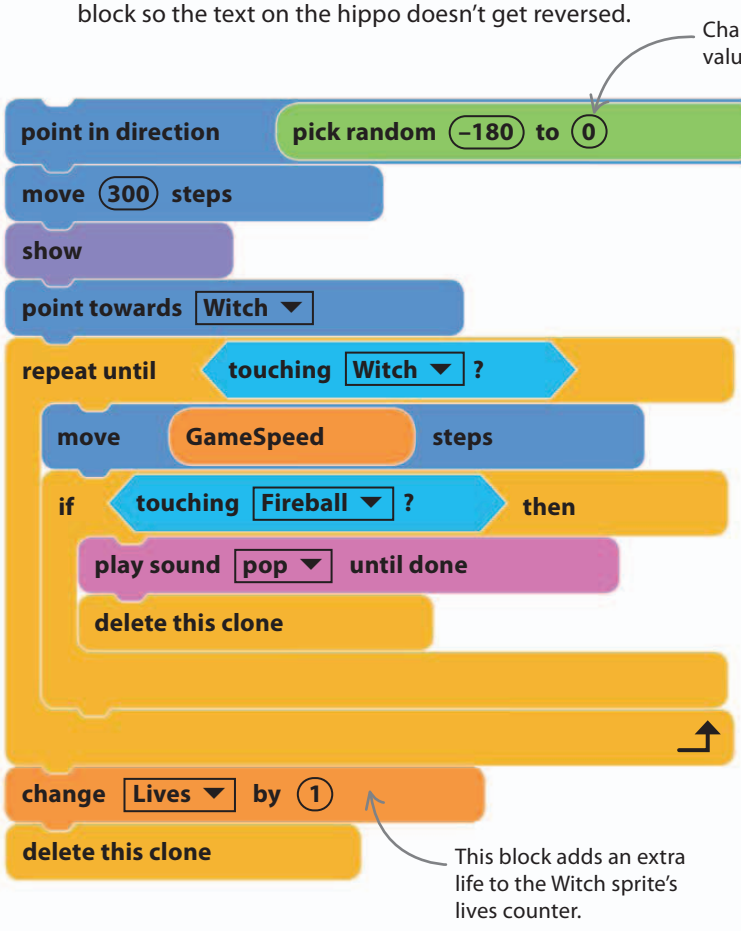
The GameSpeed setting increases with the score. For every 100 points, the speed increases by 1. When the score is 0, GameSpeed is 1. When the score is 50, GameSpeed is 1.5, and after 100 points the game runs at double speed.

Extra lives hippo

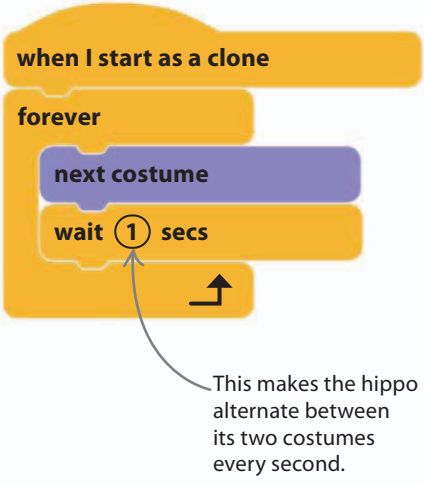
So far you've mainly added enemies. To help the player, add a friendly flying hippo that gives the witch extra lives if it reaches her without getting hit by a fireball.

41 Copy the Bat2 sprite, but replace its costumes with two copies of hippo1. Use the paint editor to write the messages "EXTRA LIFE" and "DON'T FIREBALL ME!" on the costumes so the player knows it isn't an enemy. Rename the sprite "Hippo".

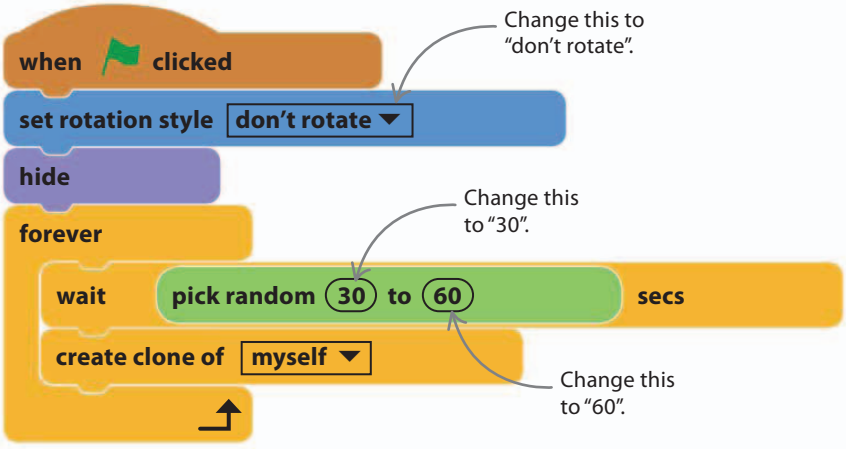
42 Amend the scripts so that instead of gaining a point when you fireball the hippo, you earn an extra life when it touches you. Change the value in the "point in direction" block so the text on the hippo doesn't get reversed.



43 Change the wait time in the costume script so that the hippo swaps costumes once a second, giving players time to read the signs.



44 To avoid making the game too easy, make the extra lives hippos rare. Change this script so they appear only every 30–60 seconds.

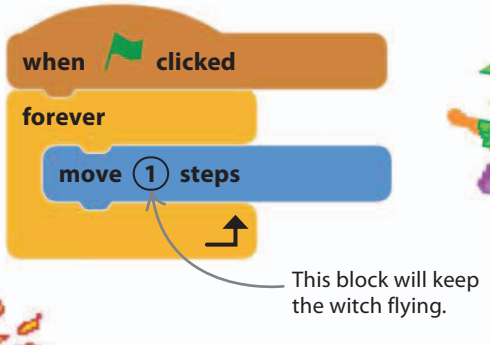


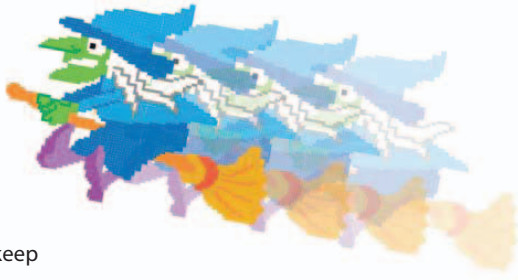
Hacks and tweaks

Now that your game works, you can experiment and make it your own by changing and adding elements. Try these suggestions to get started.

▷ Flying Witch

You can make the witch fly instead of rotating on the spot by adding the script shown here. To make her turn faster while flying, increase the numbers in her "turn" blocks.



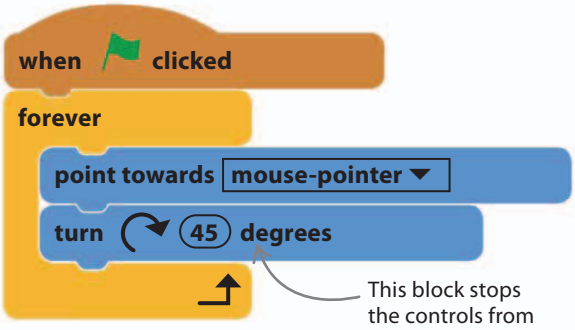


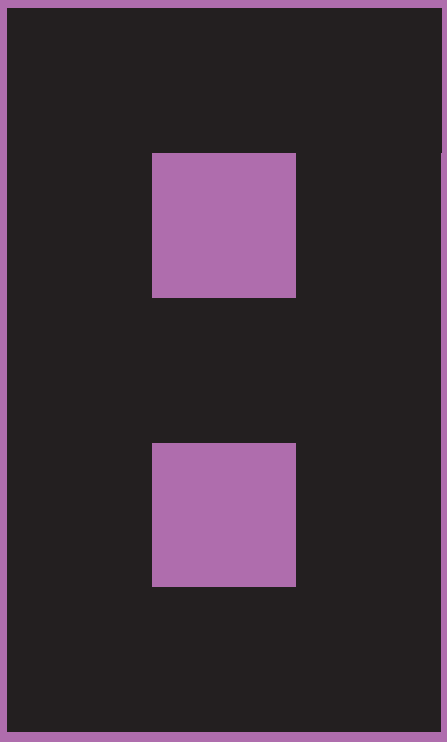
△ Spell binder

Can you think of another spell that the witch can cast? Tweak her script and costumes so she strikes her enemies with lightning, or make her cast some other fancy spells.

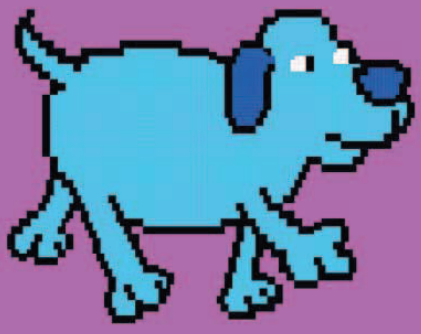
▷ Mouse control

Use this script to let the player spin the witch with a mouse rather than the keyboard. If the game is too easy, increase the GameSpeed value. You can also try changing the code so the computer mouse casts the fireballs.





Dog's Dinner



How to build Dog's Dinner

Dog's Dinner is a platform game. In this type of game, the player's character jumps from platform to platform collecting goodies and avoiding enemies and traps. The key to success is timing your jumps perfectly so you stay in the game.

AIM OF THE GAME

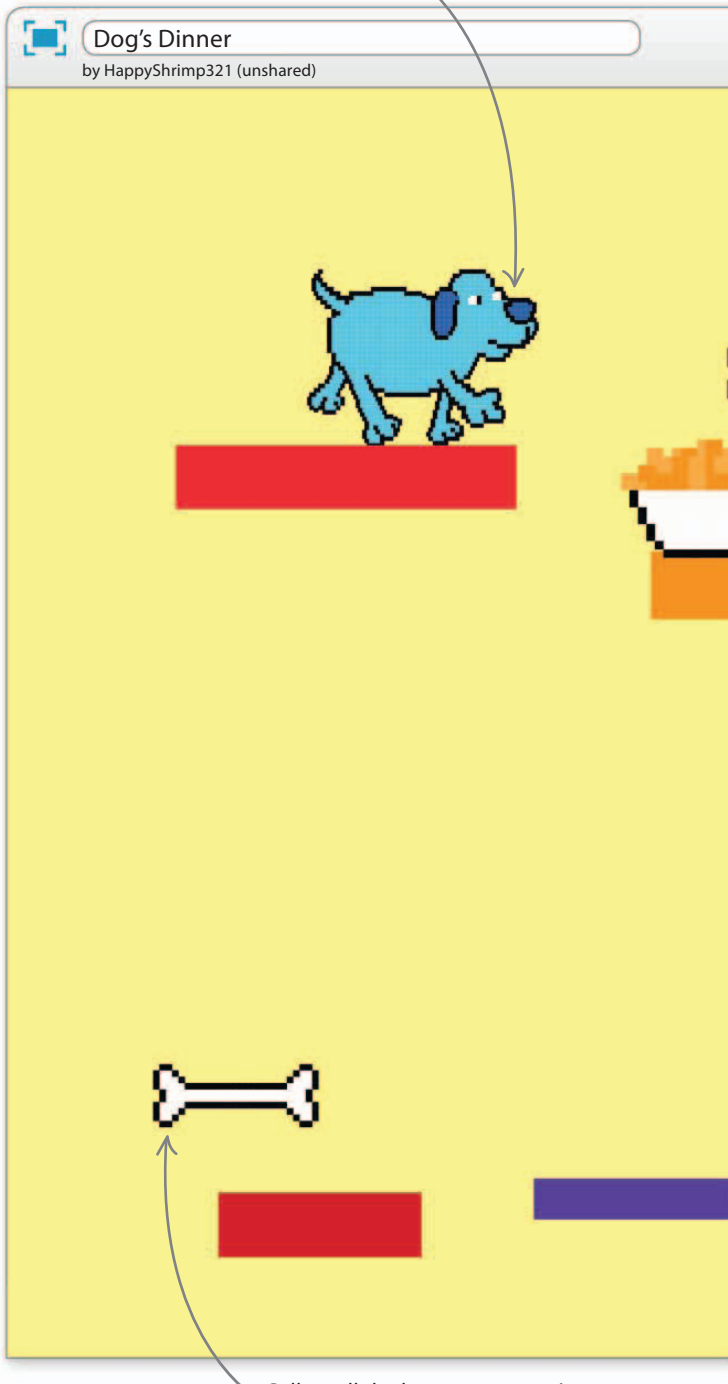
The dog likes bones but hates junk food. Steer him through three levels, jumping from platform to platform. Collect all the tasty bones on the stage and then go through the portal to the next level. But make sure he avoids the unhealthy cakes, cheese puffs, and donuts!

◁ **Dog**
Use the left and right arrow keys to make the dog run. When he needs to jump, press the space key.

◁ **Bones**
You need to collect all the bones to open the portal to the next level. It will remain shut until you have them all.

◁ **Junk food**
If the dog touches any junk food, it's game over and you have to start again on Level 1—no matter which level you were on!

The dog runs and jumps around the level. He can jump only when he's standing on a platform.

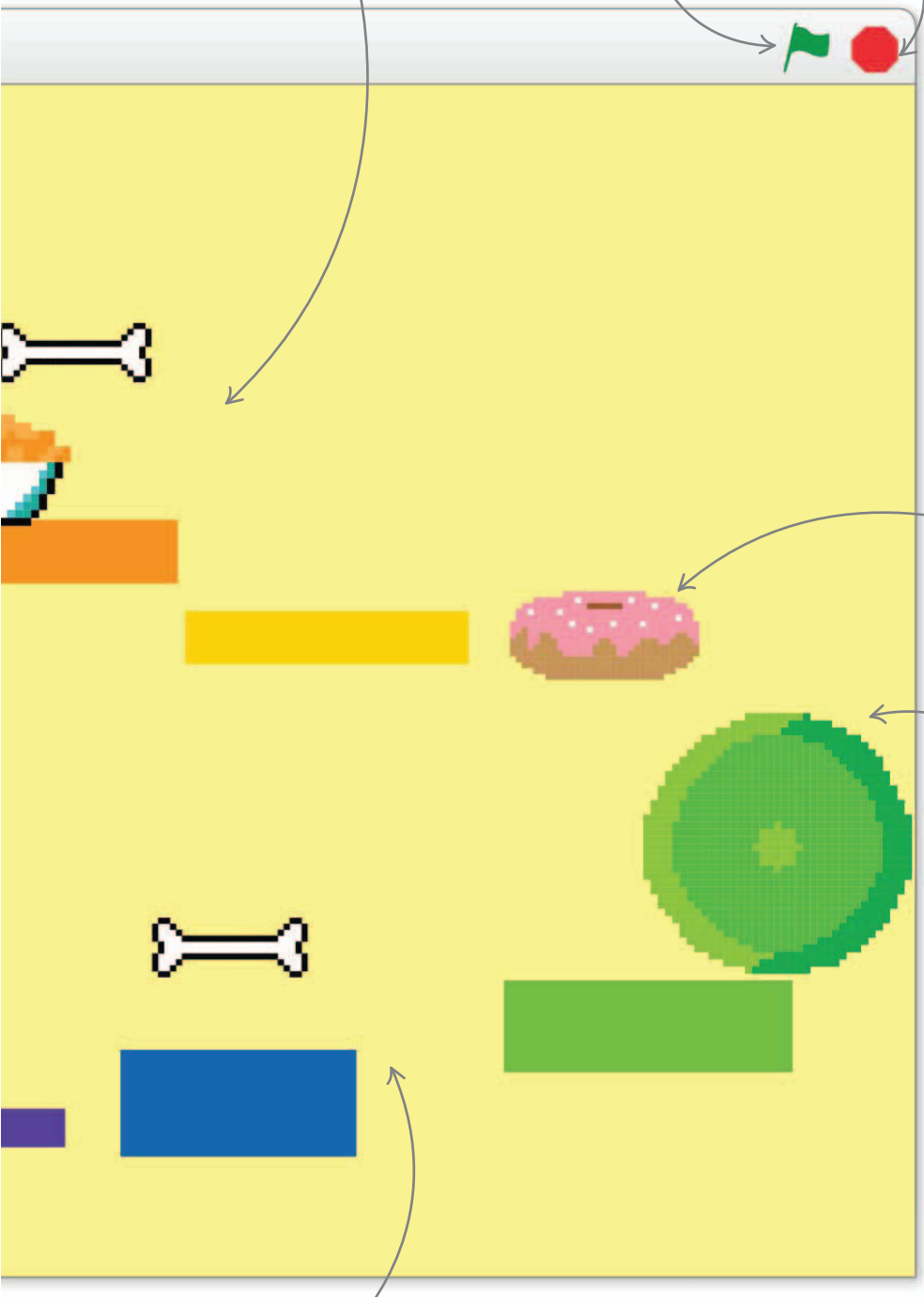


Collect all the bones—you can't get through the portal without them.

Cheese puffs and cakes are static junk foods—unlike the donut, they don't move.

Click the green flag to start a new game.

Click the stop sign to end a game.



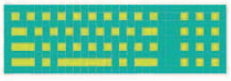
The donut is a moving hazard. It flies from side to side, getting in the dog's way.

When you've collected all the bones, the portal to the next level flashes to show it's open.

The dog must jump over the gaps.

GAME CONTROLS

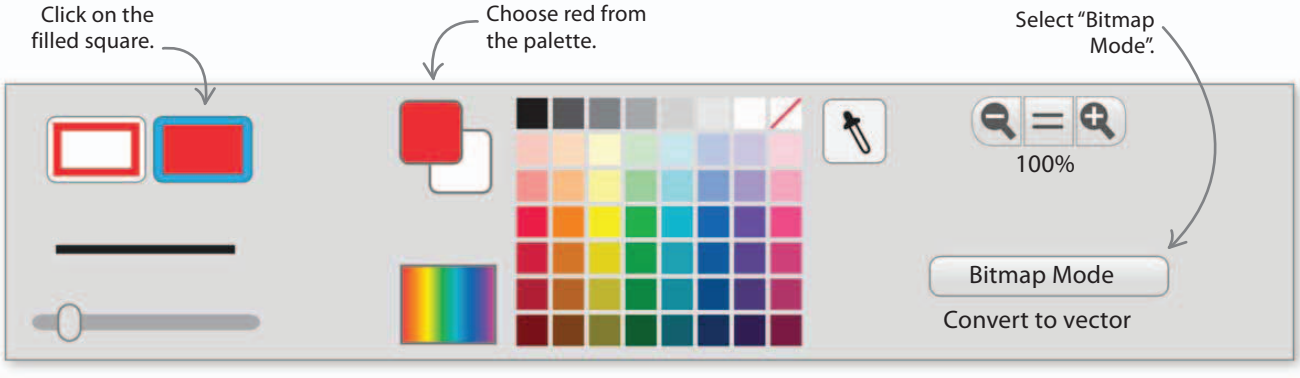
Players use the arrow keys and space bar on the keyboard as game controls.



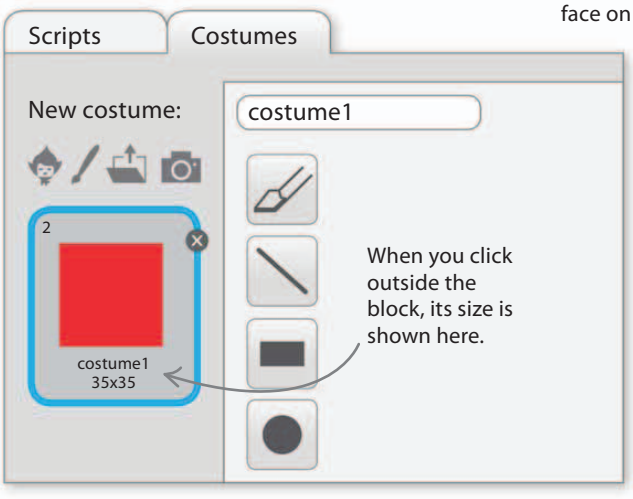
Player on a platform

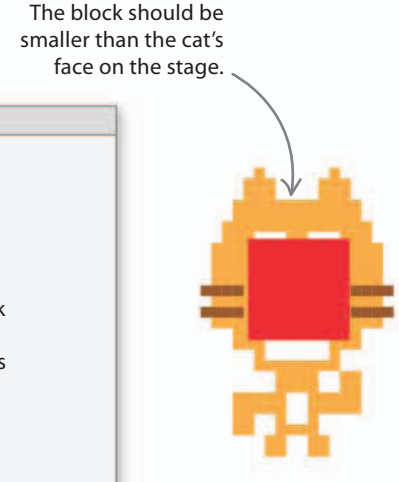
This is a complicated game, so you'll need to check your work carefully at every stage. But don't worry, the project builds gradually, one step at a time. Start by getting a very simple player sprite to work properly with a platform. At first, the player is just a red square. This makes it easy to sense collisions with the platforms. You can add the blue dog on top of it later.

1 Create a new project and name it "Dog's Dinner". To make your simple player, click the paintbrush symbol at the top of the sprites list. Make sure you're in "Bitmap Mode". Choose red in the color palette in the paint editor, select the rectangle tool, and click on the filled square option.

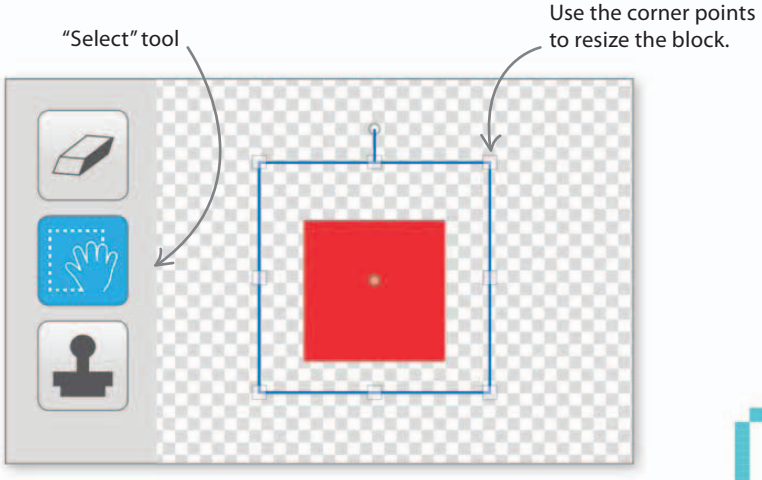


2 Hold down the shift key and drag the mouse-pointer over the paint editor to draw a small red square. If you click outside your block and look at the list of costumes, you'll see the size of the square; aim for 35x35.

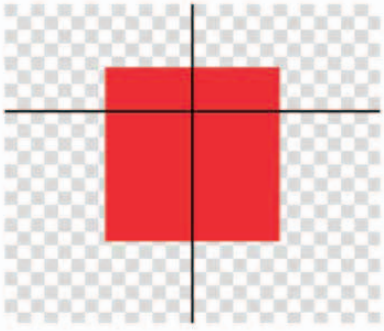




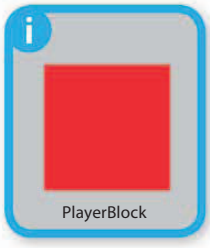
3 You can resize your block if it's too big or too small. Using the "Select" tool, click and drag to draw a square around the block. Use the corner points to resize it. Do this until the size is right.



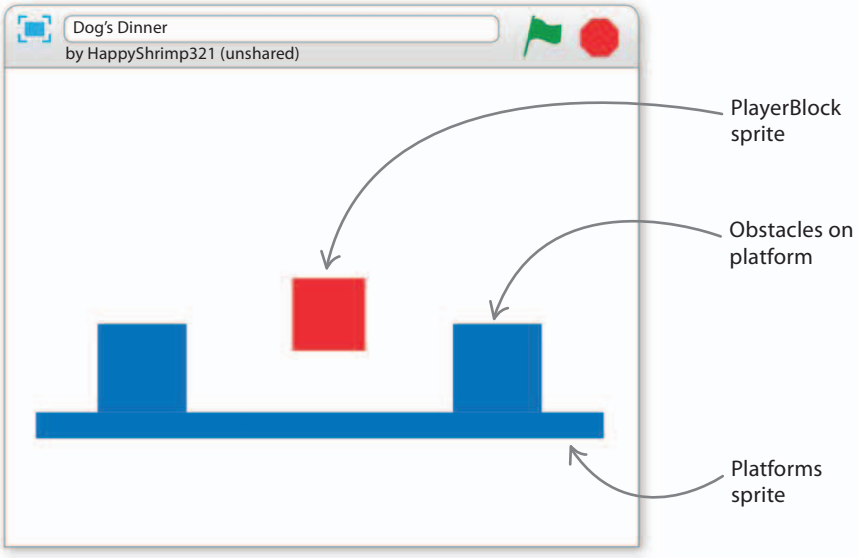
4 Select the "Set costume center" tool in the top-right corner of the paint editor. Set the center of your sprite near the top of the block (this will be useful later).



5 Rename the sprite "PlayerBlock". That's your player sprite done. Now you can delete the cat sprite.



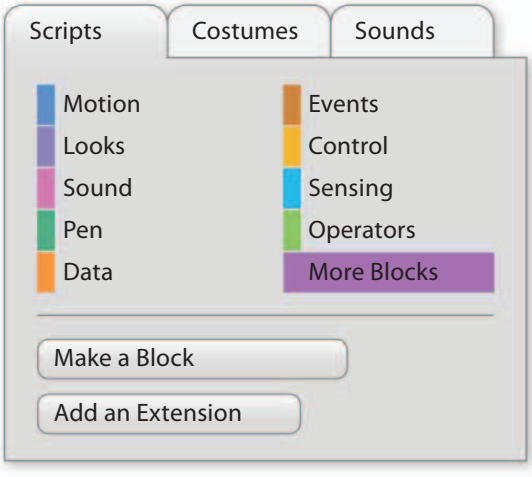
6 Now add a simple platform. Click the paintbrush symbol in the sprites list again to create a new sprite. Use the rectangle tool to draw a floor with two obstacle blocks on top. Call this sprite "Platforms". On the stage, drag your PlayerBlock and place it between the obstacles, but make sure it's not touching the platform.



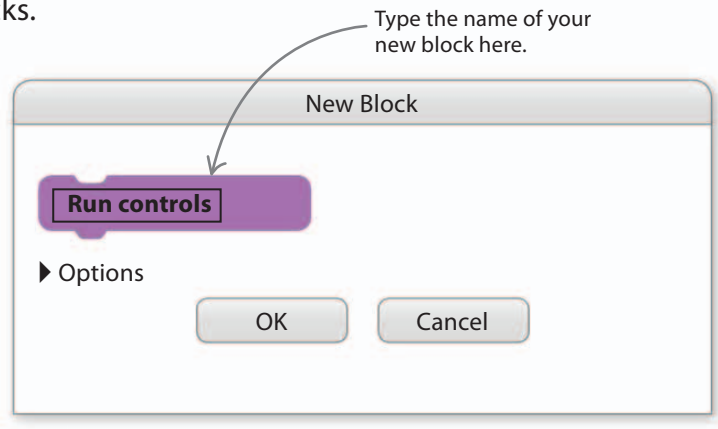
Running around

The next step is to make the PlayerBlock run when the player presses the arrow keys. You'll need a script that will stop it running through obstacles by making it reverse when it touches them. To make the code easier to read, you'll be making your own customized Scratch blocks.

7 With the PlayerBlock sprite selected, go to the blocks palette under the Scripts tab and click on More Blocks.



8 There are no blocks in this section yet, only some buttons. Click on the "Make a block" button, and a box called "New Block" will pop up. Type "Run controls" in the window to name your new block and then click "OK".

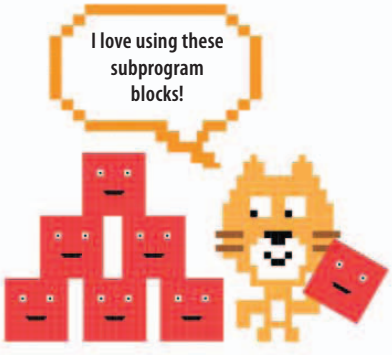


9 The new block appears in the More Blocks section, and a special purple "define" header block appears in the scripts area.

LINGO

Subprograms

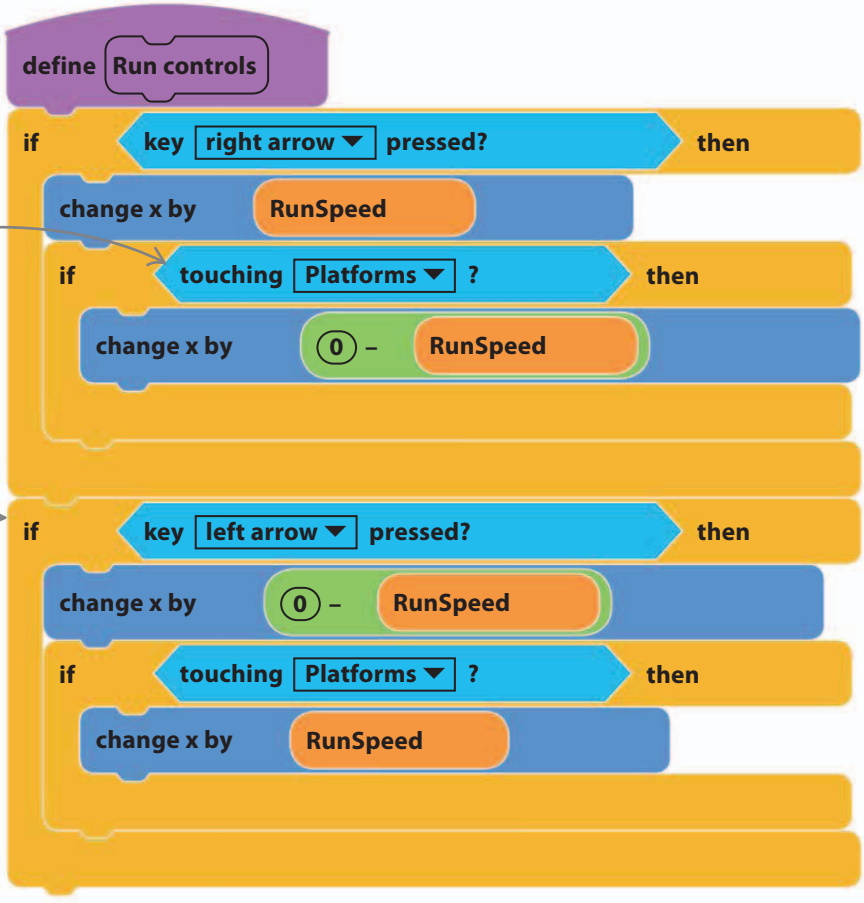
Scratch lets you group together blocks under a "define" header block and run them by using a new block that you name. This saves you building the same group of blocks again if you want to use it in more than one place. (However, the new block will only work with the sprite that you created it for.) Giving your new block a meaningful name will make your code easy to understand. Most programming languages let you take some useful code, give it a name, and wrap it up as a unit. Different languages call these units different things: subprograms, subroutines, procedures, and functions are some common names.



When the right arrow key is pressed, the PlayerBlock moves right.

If the PlayerBlock touches the platform, the move is reversed.

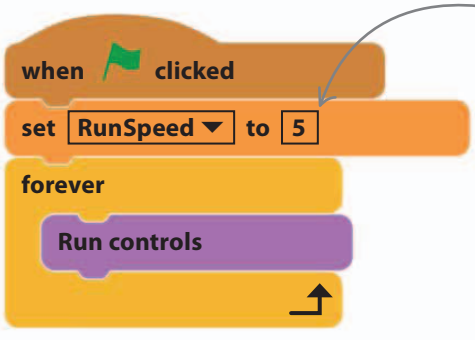
The left control works in a similar way to the right control.



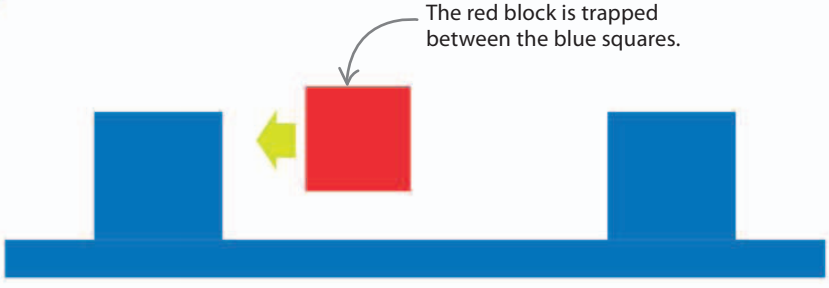
10 In the Data section, create a variable for all sprites called "RunSpeed" to control how fast the player moves left and right. Uncheck the box so it doesn't appear on the stage. Then build the script shown here under the "define" header. Anywhere we use the "Run controls" block, Scratch will now run this script.

11 Next, add the script below to use your new custom block in a "forever" loop.

Type "5" here.



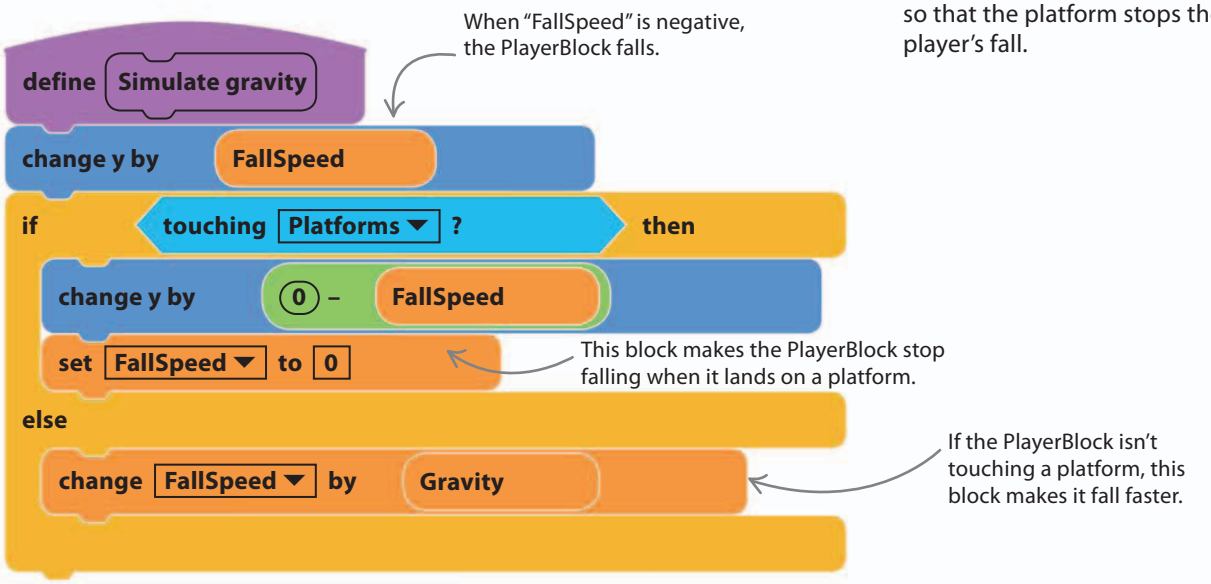
12 Now run the project. You should be able to move the red block left and right with the arrow keys, but not be able to move through the obstacles.

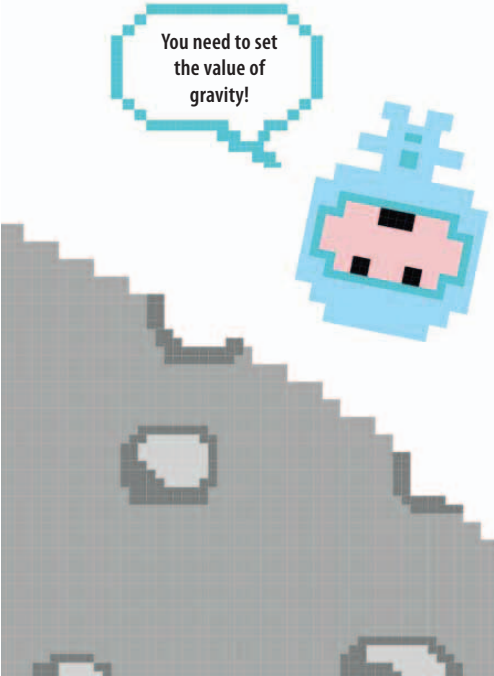


Up and down

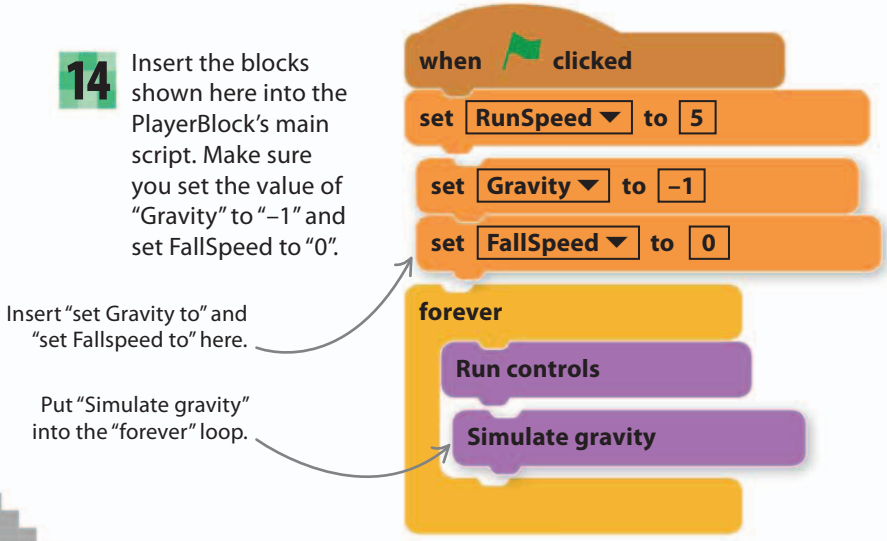
Platform games are all about jumping. You can't jump without gravity, so you need to add some simulated gravity to the game. You may recognize how the simulated gravity works if you built the Jumpy Monkey game.

13 Add two more variables for all sprites: "Gravity" and "FallSpeed". Uncheck both boxes. Then click on More Blocks and make a new block called "Simulate gravity", following the script shown here. It moves the PlayerBlock down by the amount "FallSpeed" and then checks to see if the PlayerBlock has hit the platforms. If so, it reverses the last move and sets "FallSpeed" to zero so that the platform stops the player's fall.

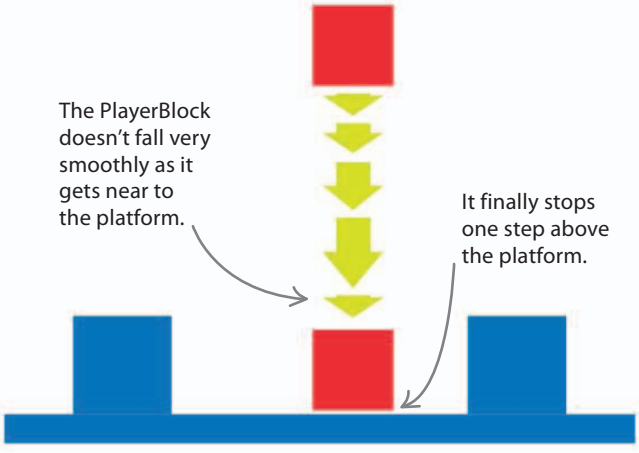




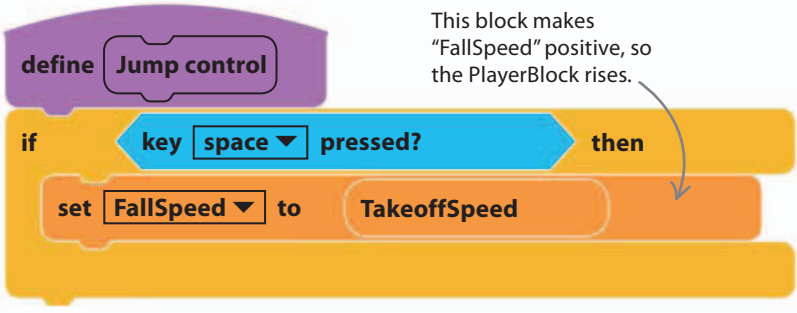
14 Insert the blocks shown here into the PlayerBlock's main script. Make sure you set the value of "Gravity" to "–1" and set FallSpeed to "0".

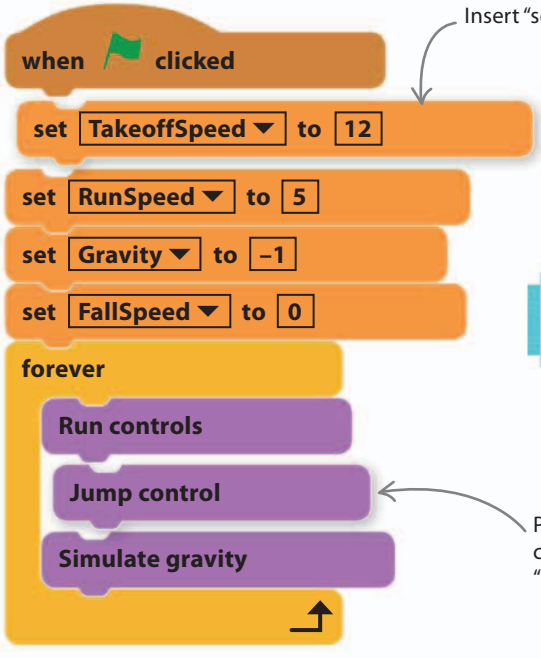


15 Run the project. Grab the red square with the mouse and drop it from above the platform. It will fall down and come to rest on the platform. But there's a problem: it slows down just above the platform. That's because our method makes the block reverse after hitting the platform and then start falling again at a slower speed. We can fix that later.



16 Now to create the jump. It's really easy: just add some new code to give the PlayerBlock an upward kick when you press the space bar. First, make a new variable for all sprites called "TakeoffSpeed". This is the player's upward speed on a jump. Then create a new block called "Jump control" and define it as shown here.

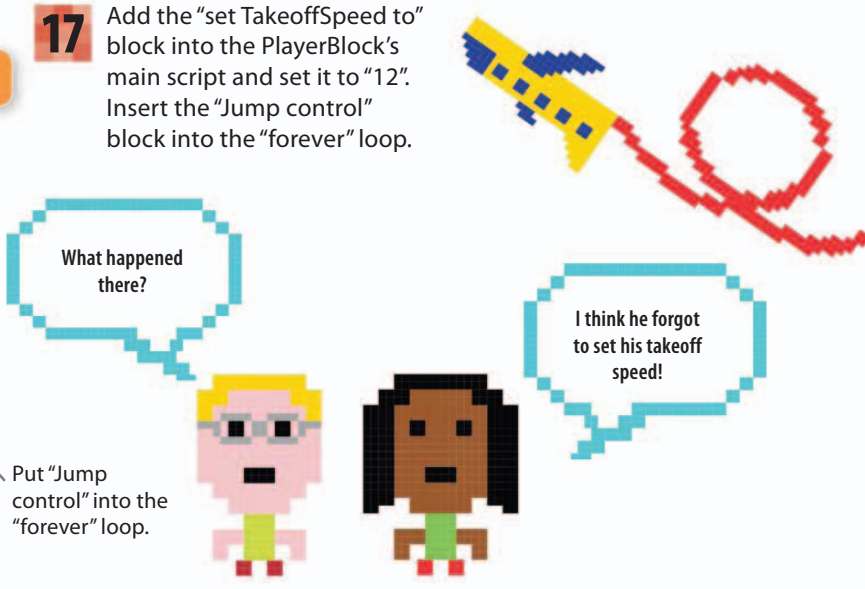




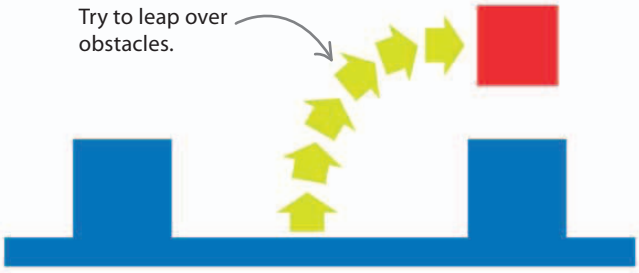
Insert "set TakeoffSpeed to" here.

Put "Jump control" into the "forever" loop.

17 Add the "set TakeoffSpeed to" block into the PlayerBlock's main script and set it to "12". Insert the "Jump control" block into the "forever" loop.



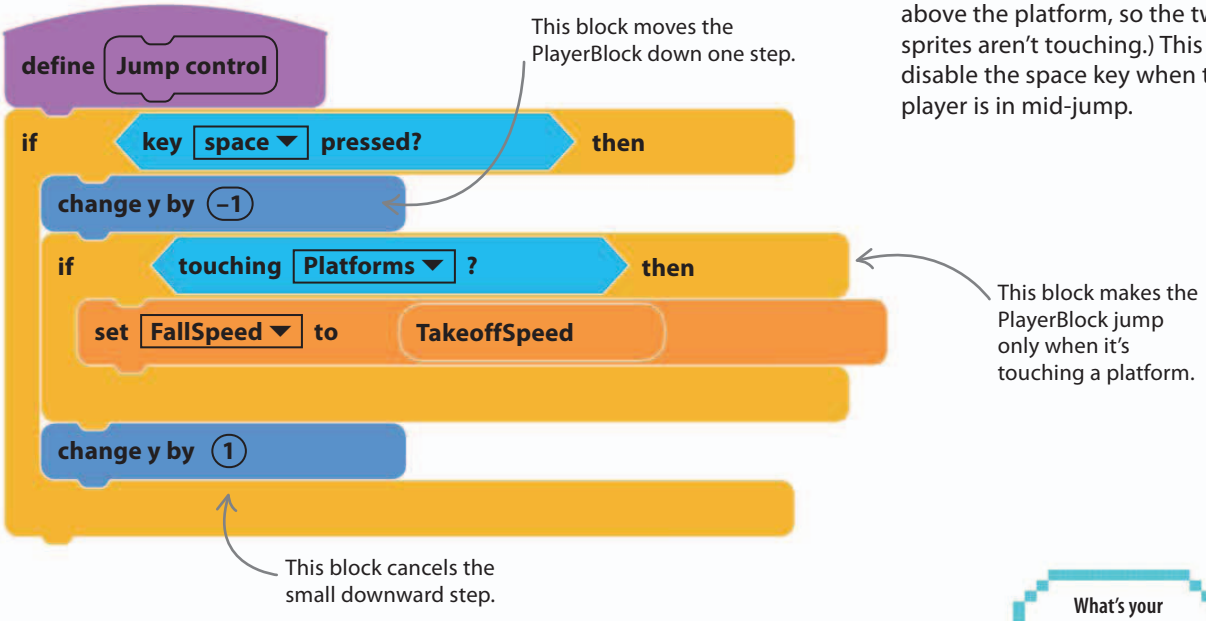
18 Now run the project. Press the space key briefly. The PlayerBlock jumps up and comes back down again. You should be able to combine the run and jump controls to jump onto or over the obstacles on the platform. You now have the makings of a platform game! However, there's another bug: if you keep the space key pressed, the PlayerBlock goes up forever.



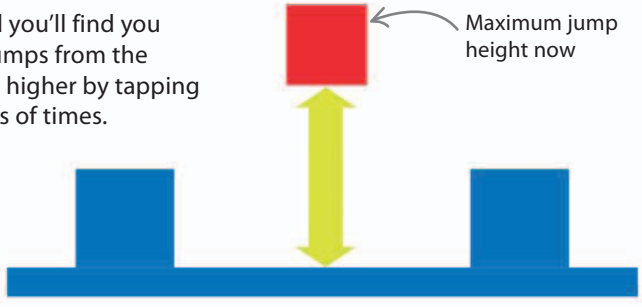
Fixing the jumping bugs

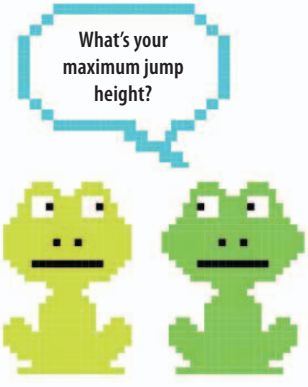
There are two bugs that spoil our jumps: one causes the PlayerBlock to jump infinitely high; the other keeps it from falling smoothly. You can fix them by tweaking the jump and gravity controls.

19 To fix the infinite jump bug, add a test to the "Jump control" script to check whether the player is on or just above the platform. (Remember that the "Simulate gravity" script leaves the PlayerBlock one step above the platform, so the two sprites aren't touching.) This fix will disable the space key when the player is in mid-jump.



20 Try the code above and you'll find you can only make single jumps from the platform and can't leap higher by tapping the space key space lots of times.





21 To fix the other jumping bug (pausing just above the platform and then falling slowly again), you need to change what happens when the PlayerBlock touches the platform. At the moment, the red square reverses by the whole "FallSpeed" number when it hits a platform. Instead, we'll make it reverse in tiny steps until it's just above the platform. Create a new variable called "ReverseStep" for all sprites. Change the "define Simulate gravity" script as shown here.

This "if then else" block works out which way the PlayerBlock needs to reverse.

If the PlayerBlock is falling ("FallSpeed" is negative), "ReverseStep" is set to +1 (up).

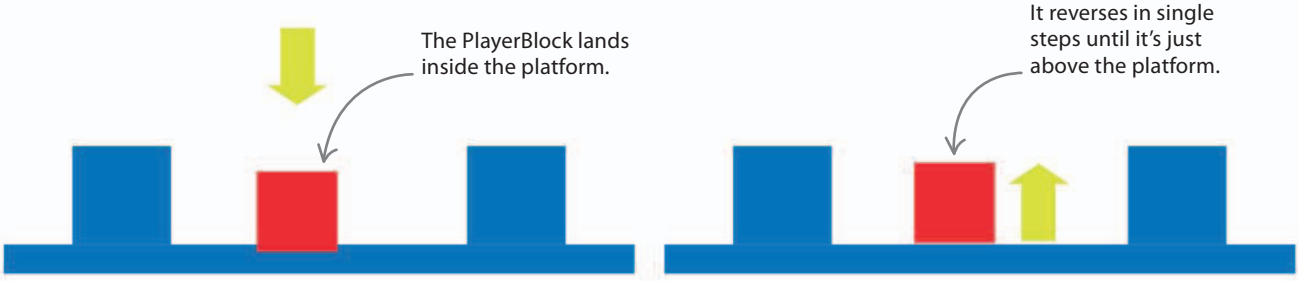
If the PlayerBlock is rising or stationary, "ReverseStep" is set to –1 (down).

The red square reverses by 1 step.

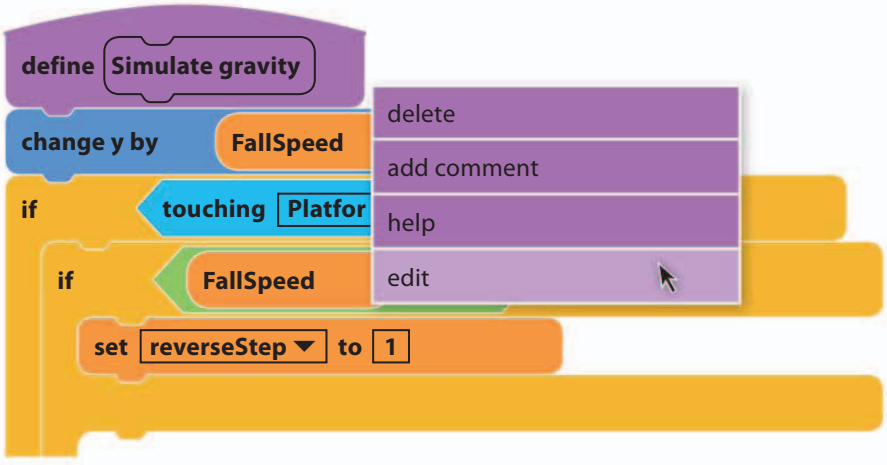
```
define Simulate gravity
change y by FallSpeed
if touching Platforms ? then
    if FallSpeed < 0 then
        set ReverseStep to 1
    else
        set ReverseStep to -1
    repeat until not touching Platforms ?
        change y by ReverseStep
    set FallSpeed to 0
else
    change FallSpeed by Gravity
```

▽ **How it works**

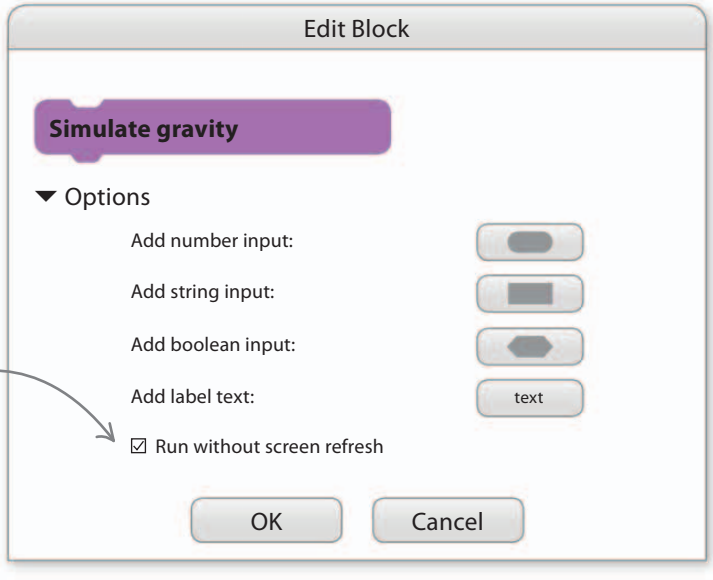
When the PlayerBlock hits the platform, the "repeat until" loop reverses the PlayerBlock until it sits just one step above the platform.



22 Try the jump again to see for yourself. You'll notice that the PlayerBlock rises back out of the platform very slowly. But we don't want that part to happen in slow motion! Scratch has a trick to fix this. Right-click on the "define Simulate gravity" header block and select "edit" from the pop-up menu that appears.

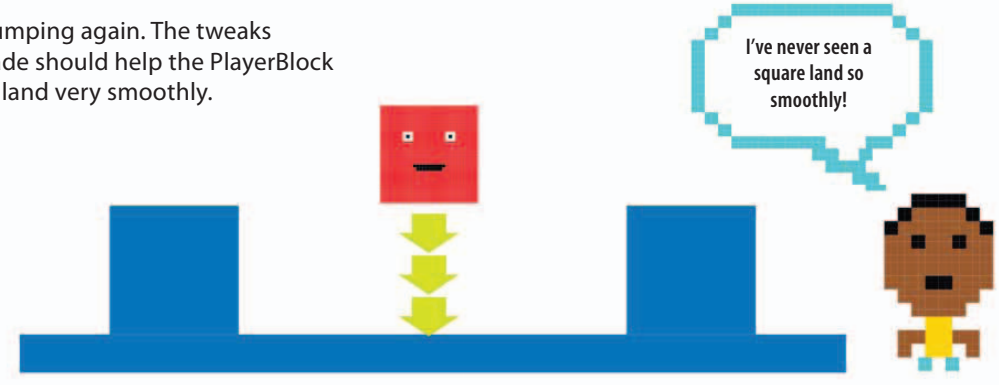


23 An "Edit Block" box appears. Click on "Options" and check "Run without screen refresh". This will make the gravity script run continually (without showing each reverse step), which will get rid of the slow-motion effect.



Check this box and the whole script will run much faster.

24 Now try jumping again. The tweaks you've made should help the PlayerBlock jump and land very smoothly.



GAME DESIGN

Which jump?

Games use many different types of jump. Which type you choose is key to your game's design. Here are three common jumps.

▽ **Single jump**

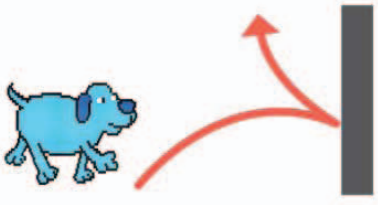
This is the jump you have in Dog's Dinner—you can only jump if you're on the ground. You go up and then down, but in some games you can steer left and right during the jump.

▽ **Double jump**

This is the jump you had before you fixed the infinite jumping bug—you can jump again in the air to go higher. In some games there are limits on double jumping—for example, you can only do it if you're going up.

▽ **Wall jump**

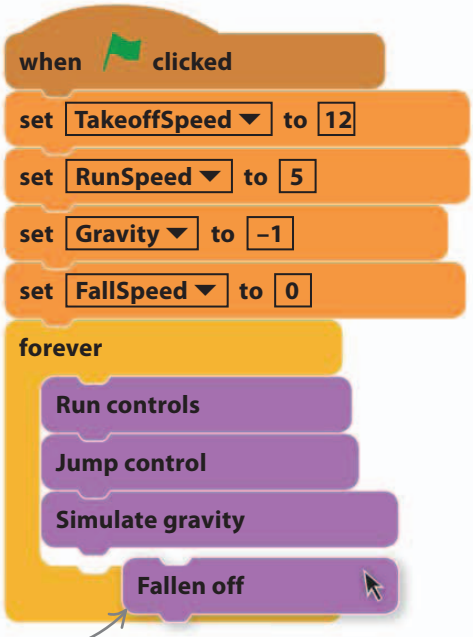
When you touch a wall, you can jump up again. Ninja-type characters often have this power. It's not very realistic but it's lots of fun!



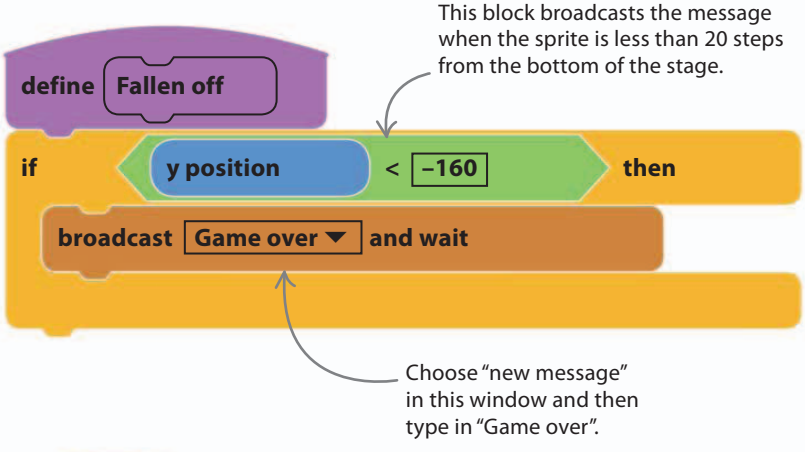
Falling off the level

Platform games are all about staying on the platforms. Add the next script to the PlayerBlock to make the game end if it falls to the bottom of the stage.

25 Make a new block called "Fallen off", shown below, to check whether the PlayerBlock is at the bottom of the stage. Add it to the "forever" loop. Then build the short script at the bottom of the page to stop the sprite when it gets the "Game over" message. Test the new code: the controls should stop working when you hit the deck.



Drop this block inside the "forever" block.



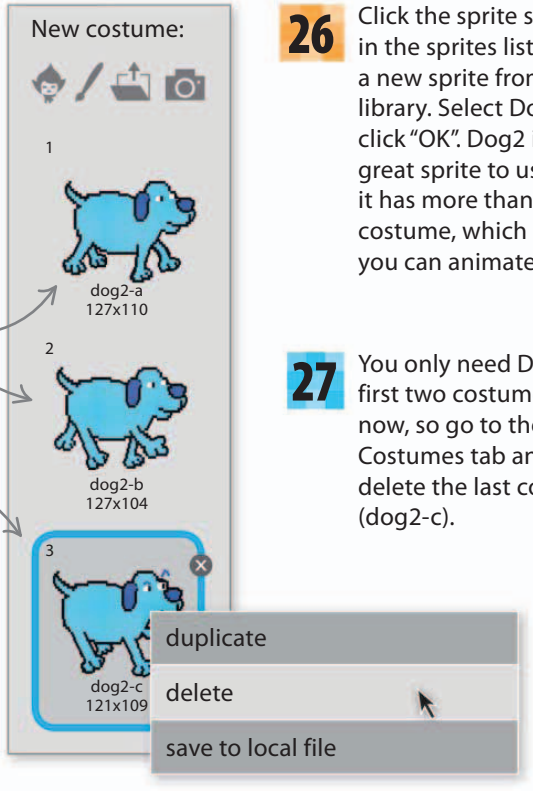
This block broadcasts the message when the sprite is less than 20 steps from the bottom of the stage.

Choose "new message" in this window and then type in "Game over".

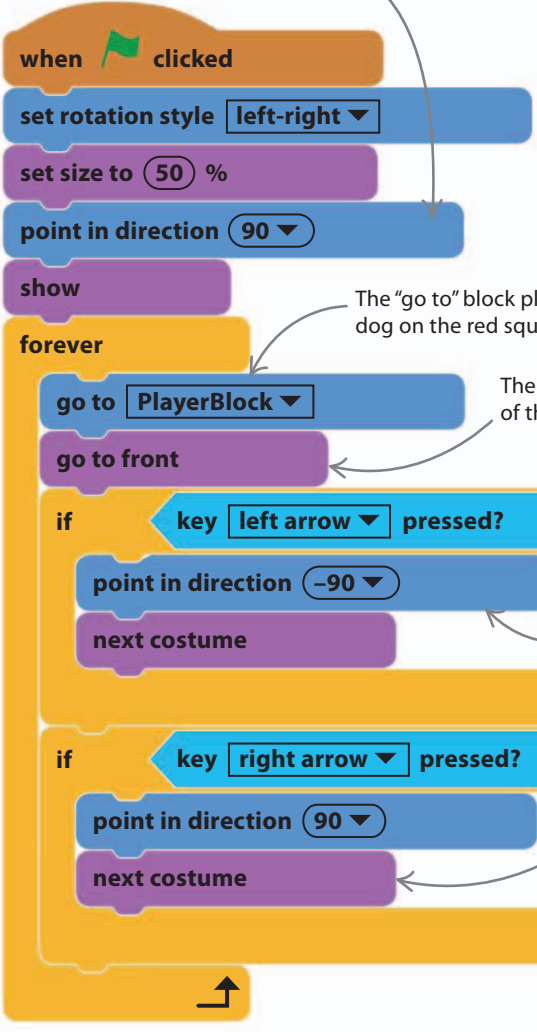
The "stop" block prevents the player from moving any further.

Adding a character

A red square isn't a very interesting main character for a platform game. You need something fun that you can animate. It's time to introduce the dog.



This block makes the dog face to the right at the start.



The "go to" block places the dog on the red square.

The dog appears in front of the red square.

The dog faces left if the left arrow key is pressed.

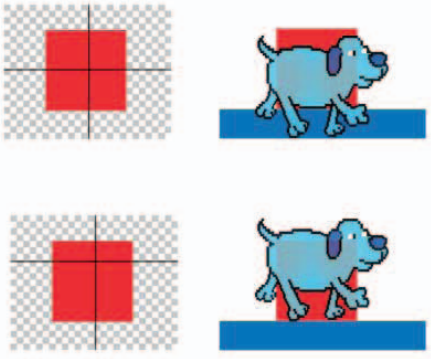
The "next costume" blocks animate the dog's walk.

26 Click the sprite symbol in the sprites list to add a new sprite from the library. Select Dog2 and click "OK". Dog2 is a great sprite to use as it has more than one costume, which means you can animate it.

27 You only need Dog2's first two costumes for now, so go to the Costumes tab and delete the last costume (dog2-c).

28 Add the script on the left to Dog2. It sticks the dog to the front of the red PlayerBlock so that it moves with it on the stage. The dog switches continually between its two costumes when you press the left and right arrow keys, which makes it look like it's walking.

You can shift the dog up or down on the platform by moving the center of the PlayerBlock sprite.



29 Run the project—the dog will now run around the stage with the PlayerBlock. If its paws are too low down on the platform, you can raise the center point of the PlayerBlock costume (since the dog sticks itself to the PlayerBlock). The dog is just decoration, so it doesn't really matter if its paws stick out as it walks. It's the red square that's doing all the collision detection.

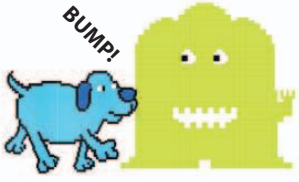
GAME DESIGN

Collision detection

Collision detection—knowing when and how two objects are touching—is a big programming challenge when building games. This book uses simple collision detection in most games, but Dog's Dinner uses a collision-detection sprite.

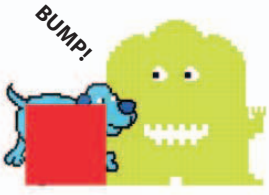
▽ Simple collision detection

This method simply checks whether the player sprite is touching a hazard. It's fine for simple games, but without extra code you don't know which part of the player is touching and how much is overlapping. And animating the sprite may mean its paws stick out when you swap costumes, creating false collisions.



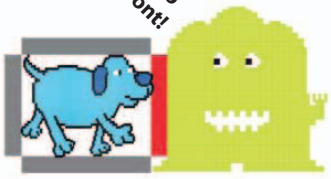
▽ Collision-detection sprite

Using a simple rectangle with an animated sprite on top (like our red square and blue dog) avoids the problem with costumes, because the PlayerBlock is always the same shape and size. But you still don't know which part of it has been touched. Programming tricks like our reversing script can solve some of the problems.



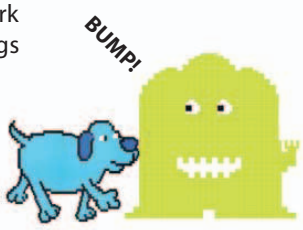
▽ Bumper sprites

You can surround the player with "bumper" sprites that move with it and detect collisions in each direction. Knowing which direction you've hit something allows you to bounce off it correctly. Extra sprites and scripts are needed for this type of detection.



▽ Mathematical collision detection

If you know where everything in the game is and exactly what size it is, then by using clever math you can work out when and how things hit each other. But be warned: this can get really complicated, as you can see below!

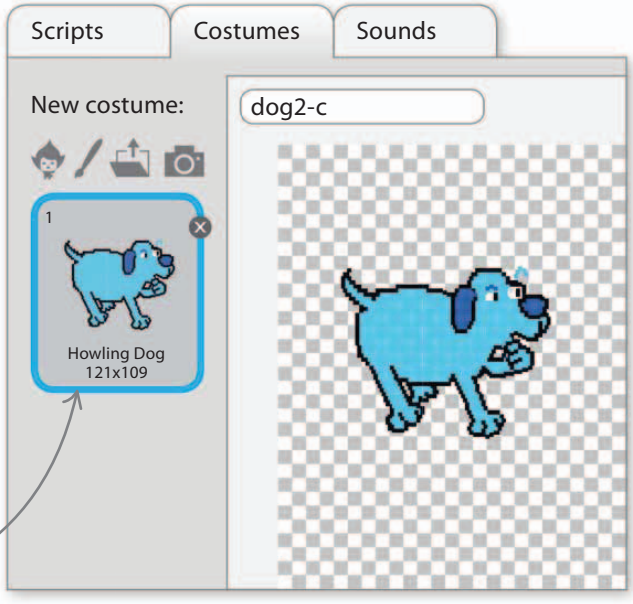


if sqrt((dogx–jellyx)^2+(dogy–jellyy)^2) < (dogR+jellyR) then BUMP!

Howling dog

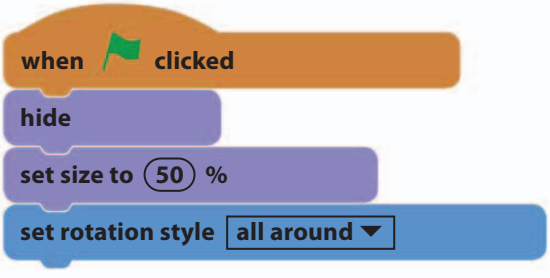
To give your blue dog more personality, make him howl with disappointment when the game ends.

30 Load the Dog2 sprite from the library again as a new sprite, but keep only the dog2-c costume this time. Rename the sprite "Howling Dog". Load the "wolf howl" sound from the sound library.

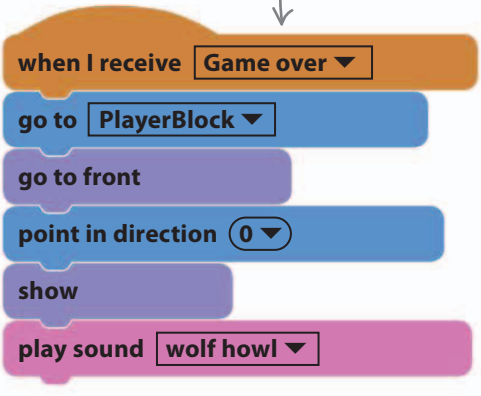


Delete the dog2-a and dog2-b costumes, because you only need dog2-c.

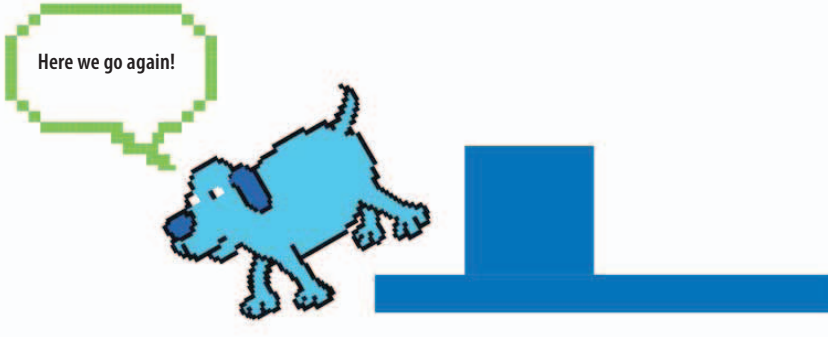
31 Add these two scripts to make Howling Dog appear when the game ends.



The Howling Dog sprite is hidden until the message "Game over" is broadcast.



32 Add the short script below to the original Dog2 sprite (not the new Howling Dog sprite) to make it vanish when Howling Dog appears. Run the project and see what happens when the dog falls off the platform.

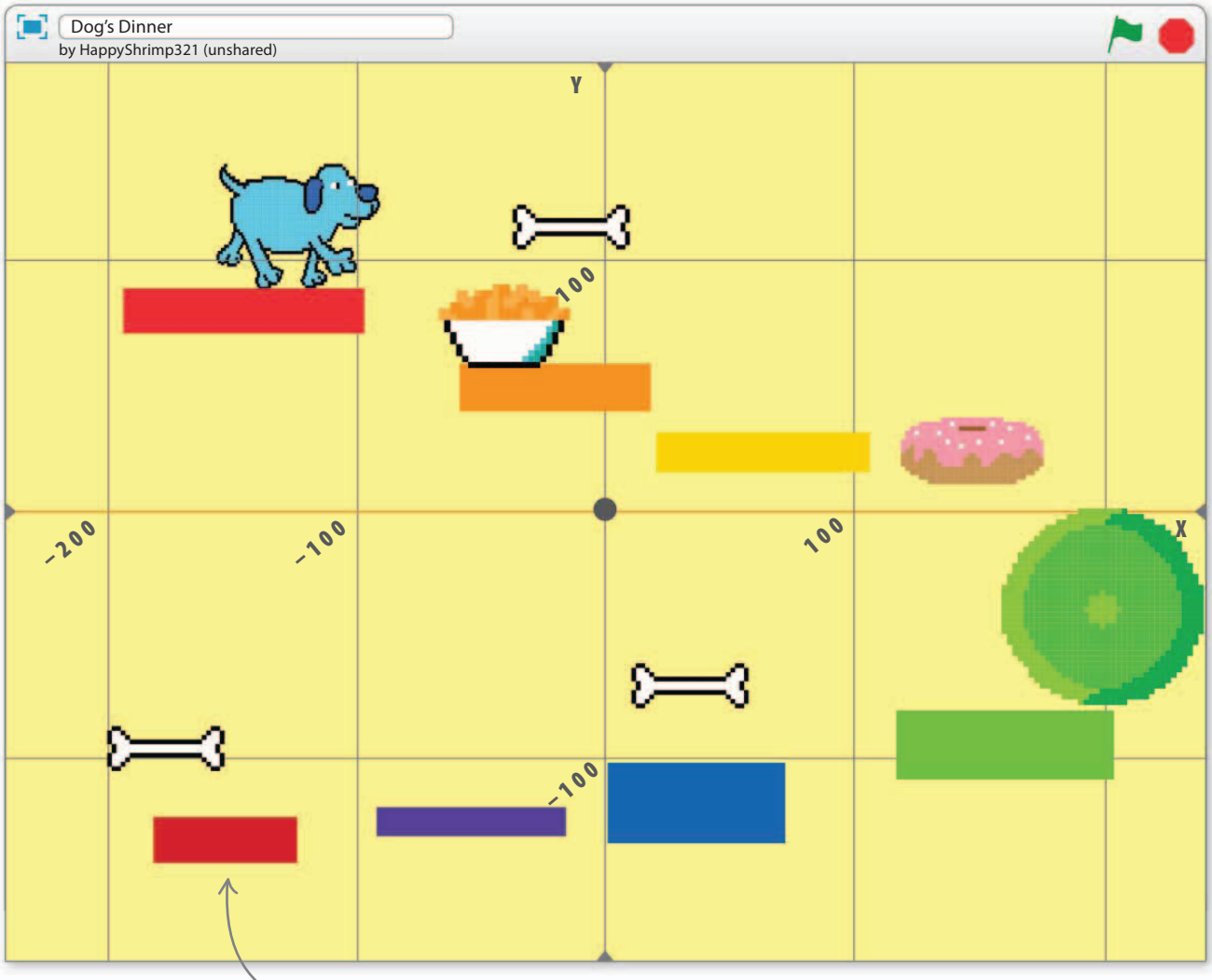


Making the levels

The next step is to create the game's three levels. You'll need to draw the platforms for each level by hand, matching the pictures on the next three pages as closely as you can. (You'll add the sprites later.) Skip forward to page 148 to find out how to paint the platforms—you can refer back to pages 145–7 once you've started.

▽ **Level 1**

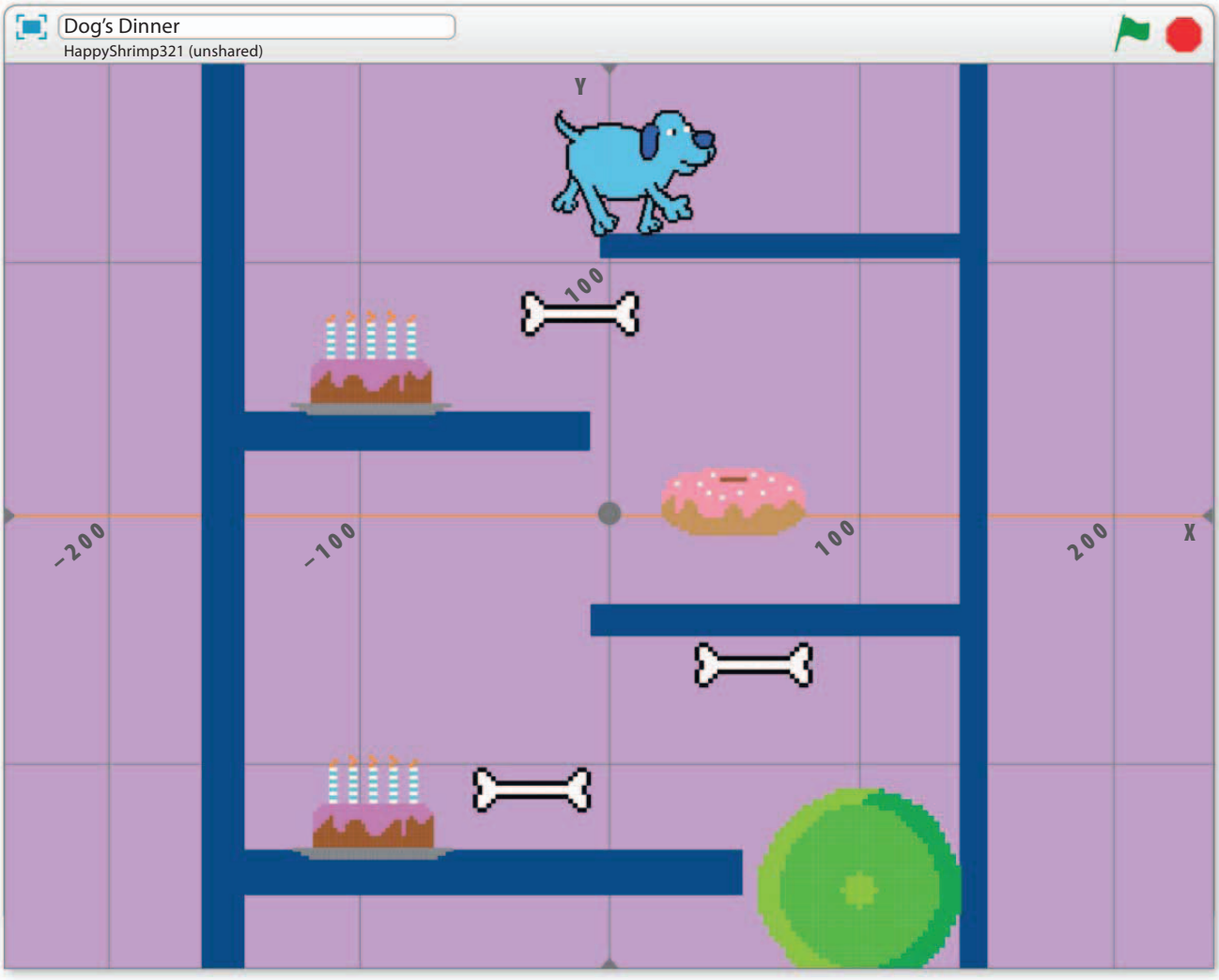
Simple colored steps allow the dog to hop downhill, collecting bones. Watch out for the donut, which slides left and right—you need to choose just the right moment to drop past it.



To help show where the platforms go, this image includes Scratch's xy-grid. To see the grid when you draw the platforms, select the stage info area in the lower left and click on the backdrop symbol to open the backdrop library. Scroll to the end and choose "xy-grid". It isn't essential to do this, but you might find it handy. You can replace the xy-grid with color backgrounds after you've made the platforms.

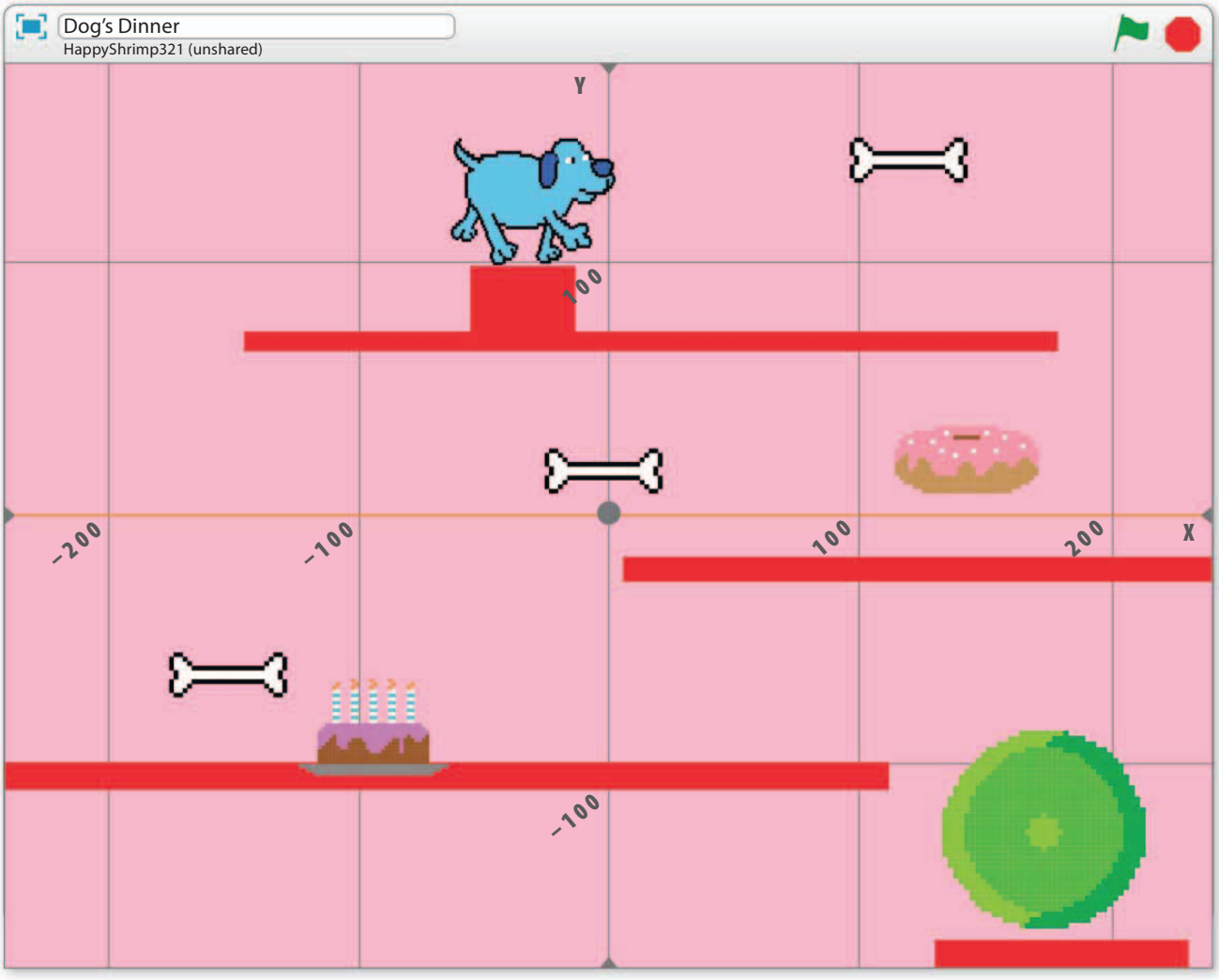
▽ Level 2

On Level 2, the platforms are arranged like the rungs of a ladder. You need to position the platforms very carefully so the dog can drop down without getting stuck but without making it too easy.



▽ Level 3

On the last level, some players will be tempted to try to jump over the donut, but it's a trap! It's much easier to collect the first bone and then go back left to avoid the donut altogether.



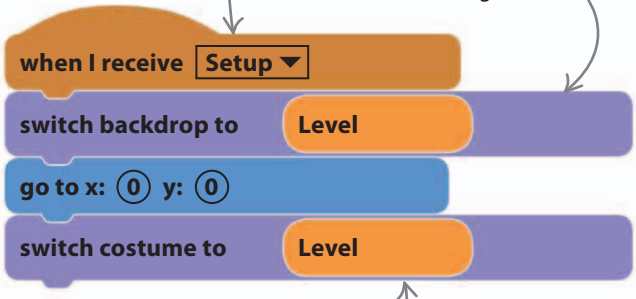
Drawing the platforms

Now to create the platforms. Dog's Dinner has three levels, so you need to create three sets of platforms. Each one will be a costume in the Platforms sprite.

33 Create a variable called "Level" for the game's three levels. Uncheck the box so that it doesn't show on the stage. To make the game use the correct level costume, add this script to the Platforms sprite. Before you start drawing, click once on this script with the mouse. This runs just this script, centering the sprite on the stage so that platforms will appear in the correct position when you draw them.

Create a new message called "Setup", which we'll use later to reset the game each time it starts.

This block changes the colored backgrounds.



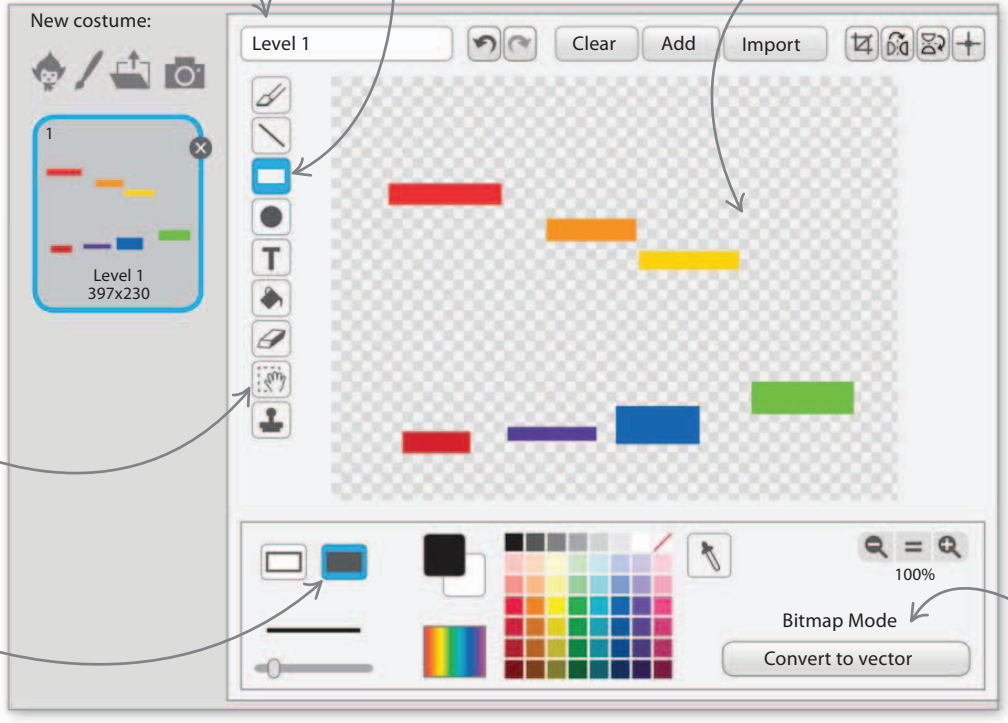
This block changes the platforms.

34 With the Platforms sprite selected, click on the Costumes tab and then use the paintbrush symbol to create three new costumes. Delete the old test platform costume. Then use the rectangle tool to draw the platforms on each level. Try to match the pictures on the previous pages. Don't worry about getting them perfect, as you can adjust them later.

Name each costume.

Use the rectangle tool.

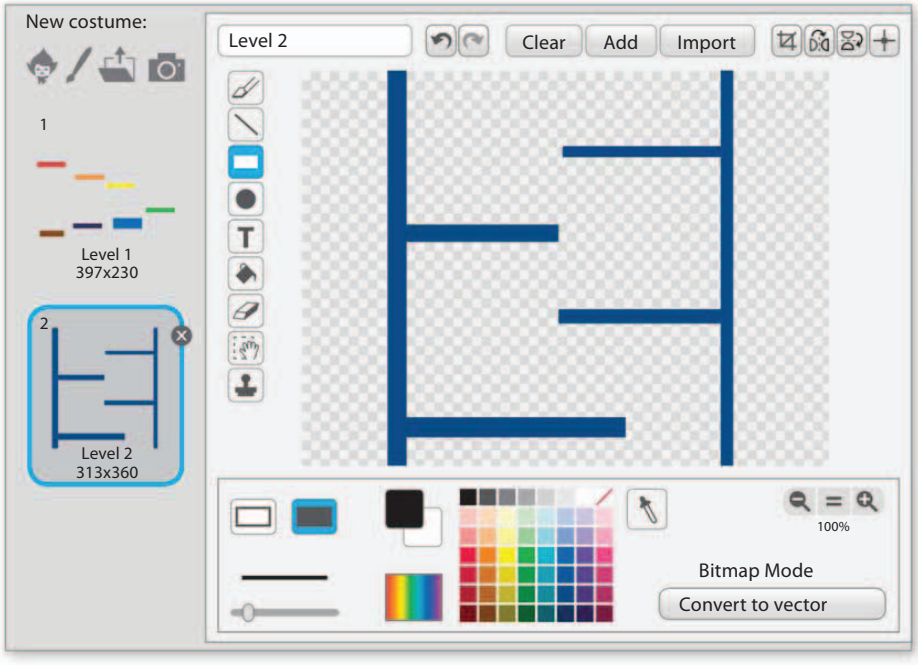
Don't add color to the checked area.



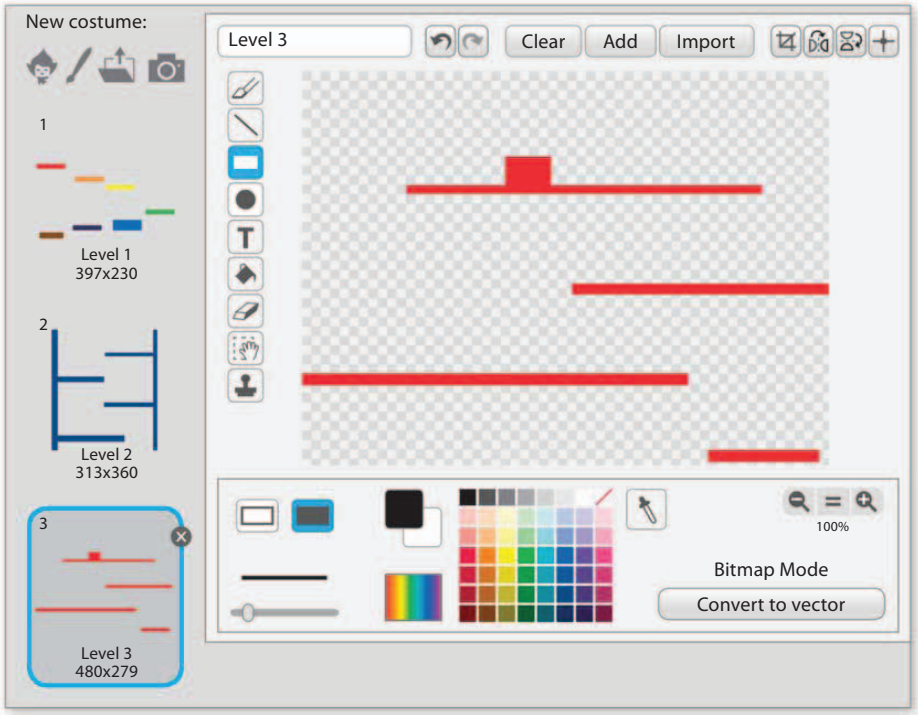
The "Select" tool lets you select and move a platform.

Select solid color.

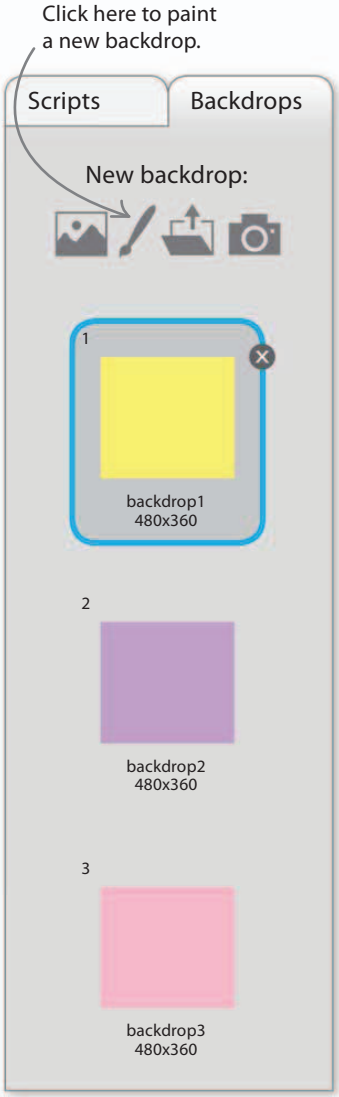
Make sure you're in "Bitmap Mode".



Make sure the costumes appear in the correct order here. You can drag and drop them to change the order.

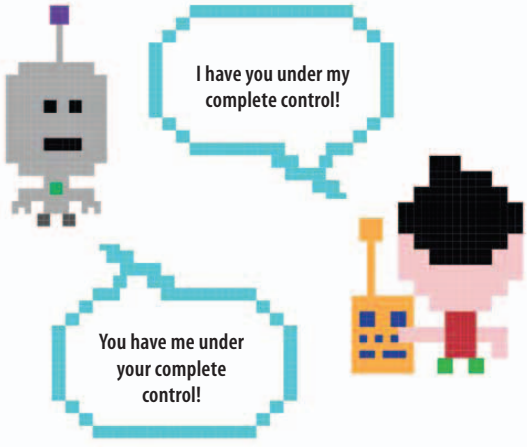


35 To add color to the backgrounds, select the stage info area to the left of the sprites list and then the Backdrops tab. Use the fill tool to fill the paint area with color. Then click on the "Paint new backdrop" symbol to make a new backdrop and fill it with a different color. Repeat to make a third backdrop.

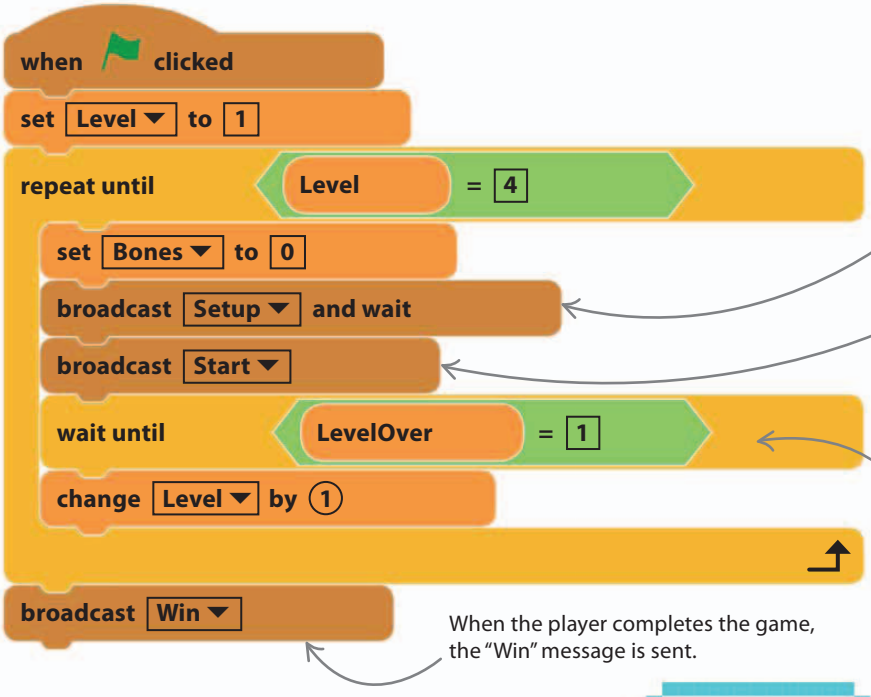


Creating a game control sprite

To make the levels change and set the start positions of all the objects on each level, you will need to build a control script. It's a good idea to keep this script in its own sprite.



36 Create two variables, "Bones" (to count the number of bones left on the level) and "LevelOver" (to show when the player has finished the current level). Uncheck their boxes. Make an empty sprite using the paintbrush symbol in the sprites list. Name it "Game Control". Add the following script. It's a loop that repeats for every level. You also need to make two new messages: "Start" and "Win".



The "Setup" message tells all sprites to move to the correct position on this level.

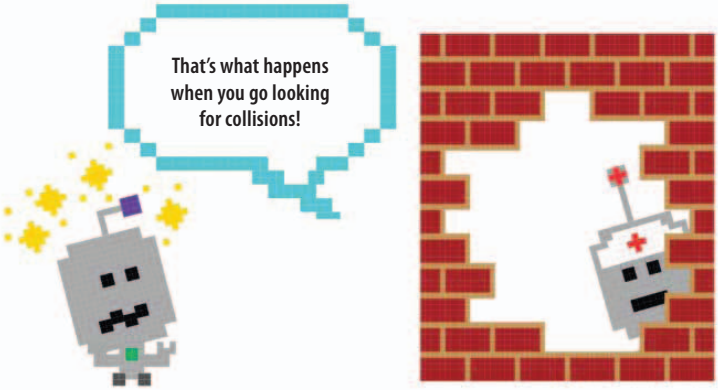
"Start" tells all sprites that this level is now running and makes them check for collisions or move.

"LevelOver" is set to 1 when the player reaches the portal, signaling the end of the level.

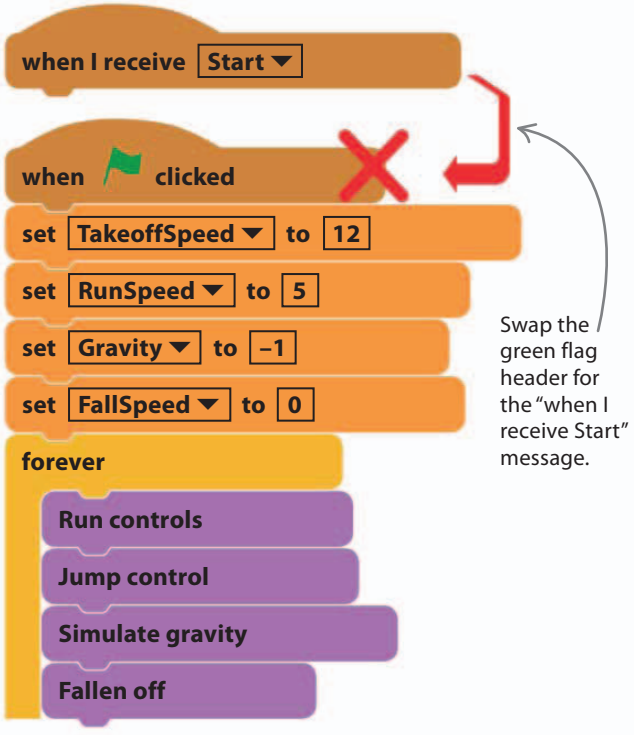
When the player completes the game, the "Win" message is sent.

△ How it works

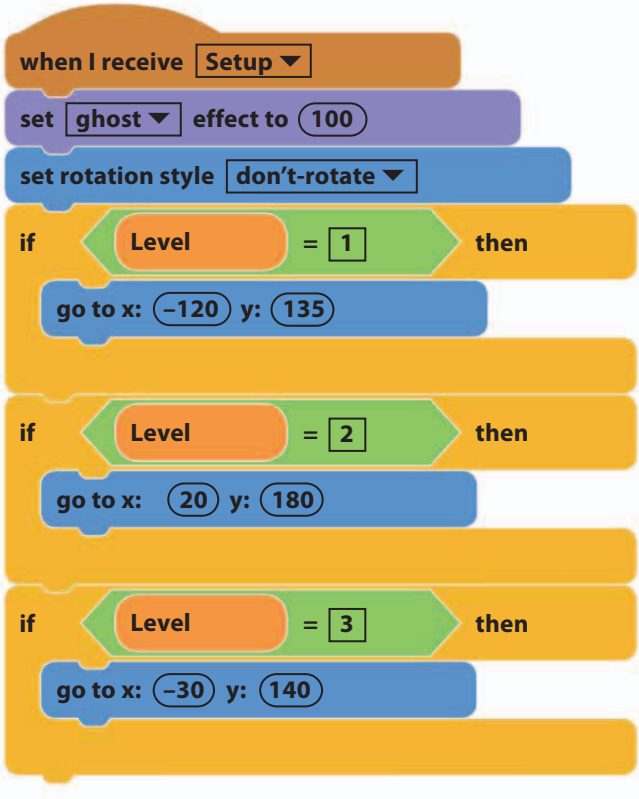
This script goes once around the loop for each level of the game. Then it moves on to the next block, which broadcasts a "Win" message to say that the player has won. The first broadcast is the message "Setup", which gets the sprites and background in position ready for the start of this level. It waits for all the receiving blocks to finish setting up before moving on. Then the "Start" message is sent. This triggers all the working scripts for the level, which move the sprites and look out for collisions.



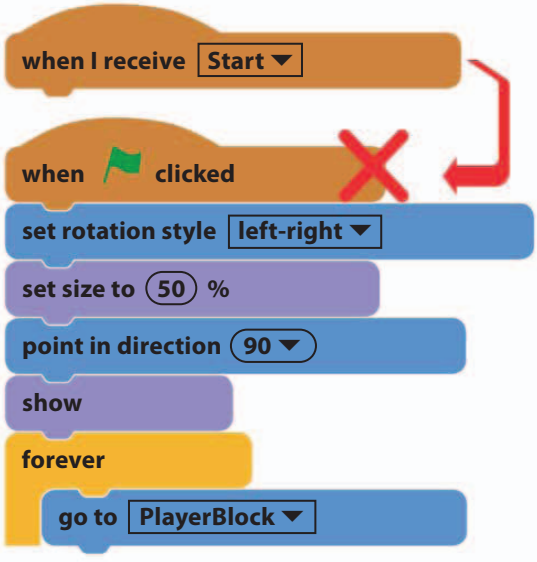
37 Change the PlayerBlock's main script so that the Game Control sprite's loop can trigger it with the "Start" message.

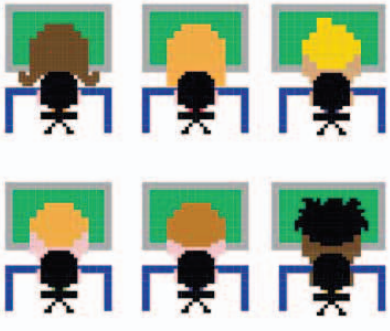


38 With the PlayerBlock sprite still selected, add this next script to set its start position for each level when the "Setup" message is received. The script starts by ghosting the sprite completely, so that you see only the dog, not the red square. Ghosting is different from hiding a sprite because collisions can still occur—which is exactly what we want!



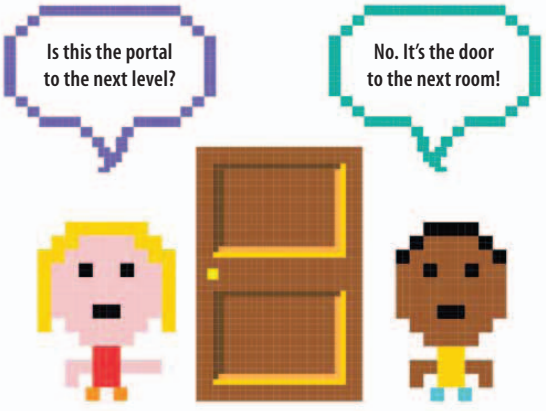
39 You also need to change Dog2's script so that it's triggered by the "Start" message.





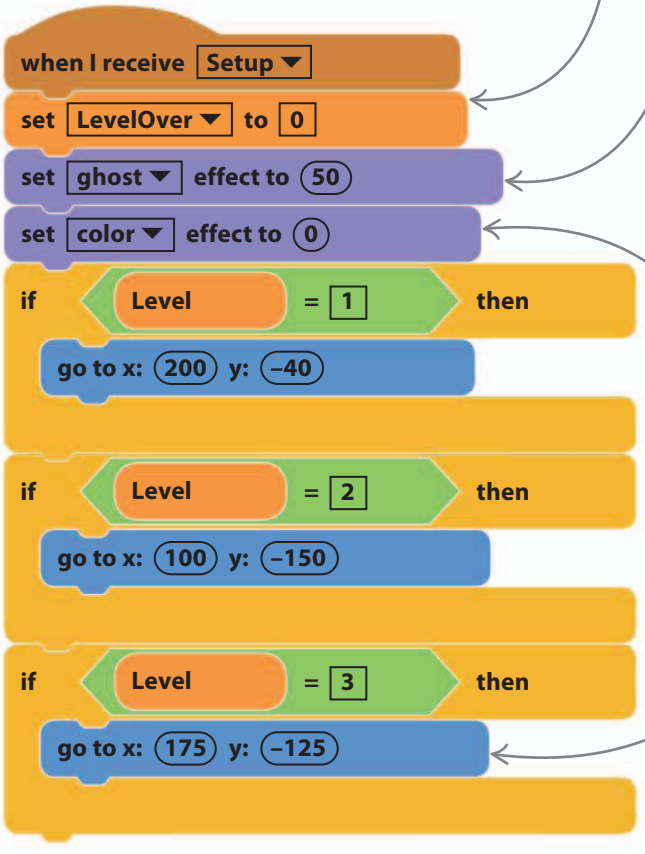
Placing the portals

Your game needs portals for the player to be able to progress through the levels. A portal is like a doorway that opens up when the player has completed a level.



40 Try running the project again. You should be able to run and jump on the Level 1 platforms, but at the moment there's no way to get to Level 2. Click the sprite symbol in the sprites list to open the sprite library. Add Button1 to your game and change its name to "Portal".

41 The portal needs a "Setup" script to position it correctly in each level and to make it slightly see-through before it opens.



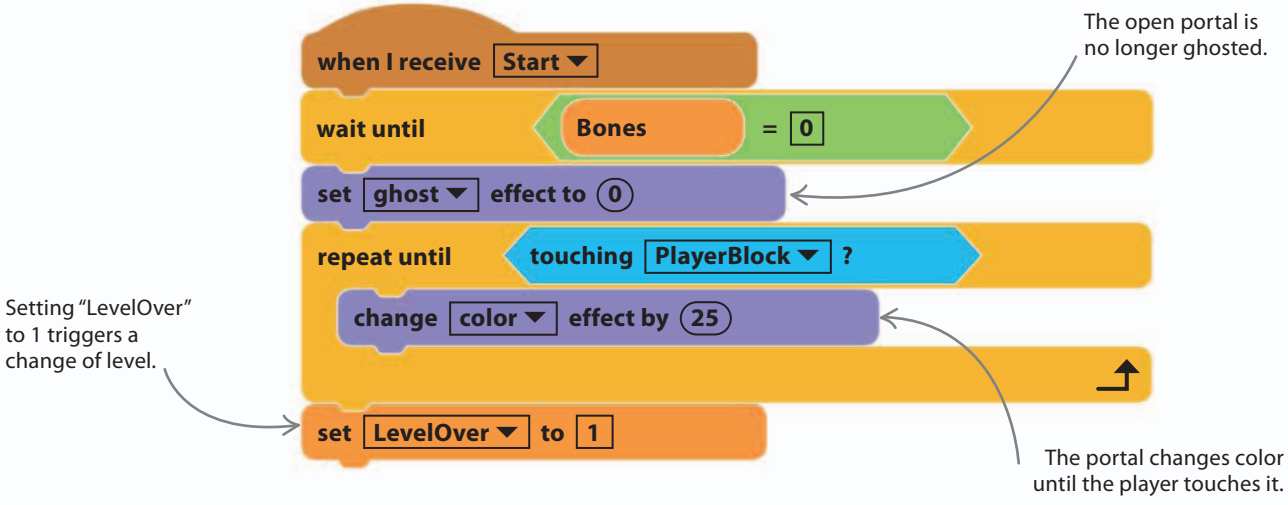
"LevelOver" is set to 0 to show that the level is not over because the bones haven't been collected.

The "ghost" block makes the portal slightly transparent.

The "set color effect to" block is set to 0, which means that the sprite appears in its normal green color at the start of each level.

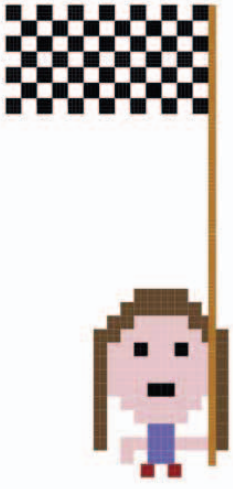
The "go to" blocks set the portal's position on the stage for each level. Don't worry if the portal isn't in quite the right place—we'll fine-tune everything later.

42 The Portal's second script waits for the bones to be collected and opens the Portal by showing it changing color until the player touches it. Run the game. We haven't added bones to the game yet, so the portal will open immediately. You should be able to run through all the levels. If you can't, go back and carefully check all the steps.



LINGO

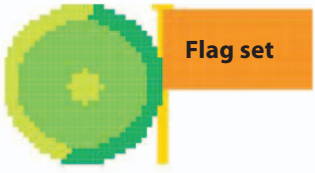
Flags



"LevelOver" is a variable that the portal's script uses to tell the Game Control sprite when the level is complete. (Remember the "wait until" block in the Game Control sprite's loop? It makes the script wait before switching to the new level.) "LevelOver" allows different parts of a program to communicate. Programmers call a variable used in this way a "flag", and it is an alternative to using a message.

Flag unset
LevelOver = 0

When "LevelOver" is 0 (because the level isn't over), we say that the flag is unset. When "LevelOver" is 1 (because the player has reached the open portal), we say that the flag is set. Messages can only start scripts, but by using a flag you can pause a script in the middle until something happens. In the Game Control sprite's loop, the "wait until" block pauses until the flag equals 1.

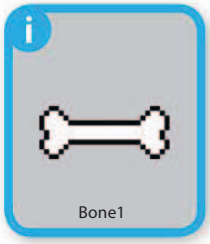


Flag set
LevelOver = 1

Bones for the dog

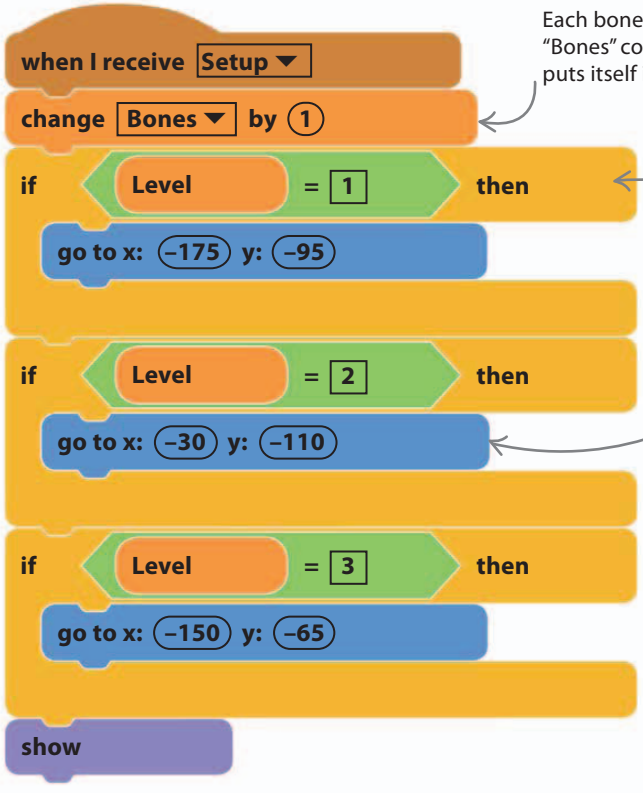
It's not much fun just racing through the levels without having anything else to do. Let's add some bones that the dog must collect to open the portal. After all, he's getting hungry!

43 Create a new sprite and draw a bone about the same size as the dog. Use the paintbrush tool for the black outline and the fill tool to color it white. Call it "Bone1". Don't forget to center it.



44 Add the script on the right to set Bone1's position on each level. The x and y coordinates determine where this bone will appear on the stage at each level of the game. The positions may not match your platform designs exactly, but they'll be fine for now.

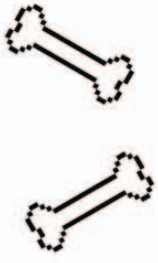
BONE 1

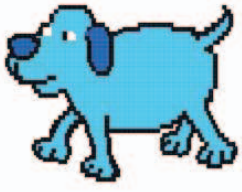


Each bone adds 1 to the "Bones" counter when it puts itself in position.

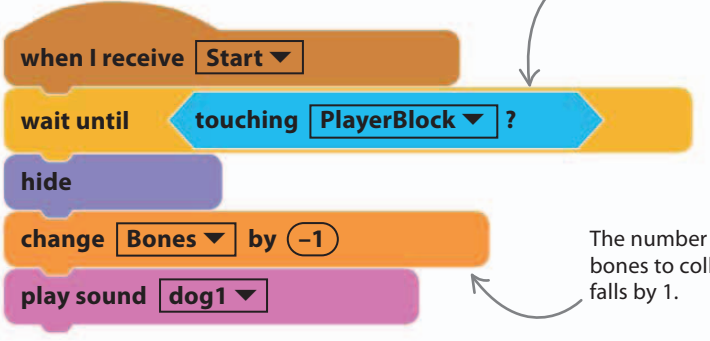
The "if then" blocks set the position of Bone1 for each level.

You can fine-tune the positions of the bone later on.





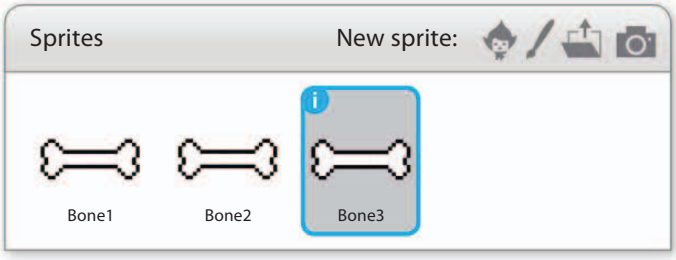
Nothing happens with this script until the dog touches the bone.

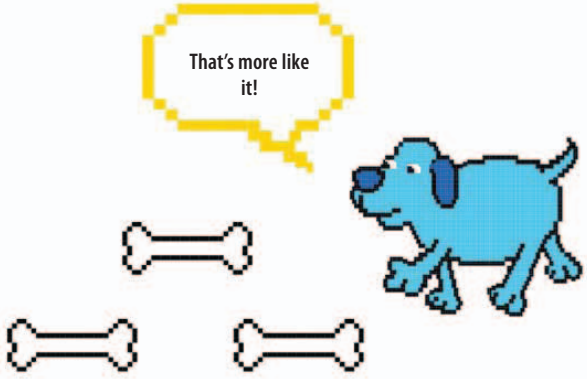


The number of bones to collect falls by 1.

45 Add the "Start" script shown on the left to Bone1 to make it hide when the dog collects it. It also updates the "Bones" counter. Load the sound "dog1" to this sprite, so the dog gives a happy "woof" when he gets a bone. Run the project. At the moment, you should only have to collect one bone before the portal opens.

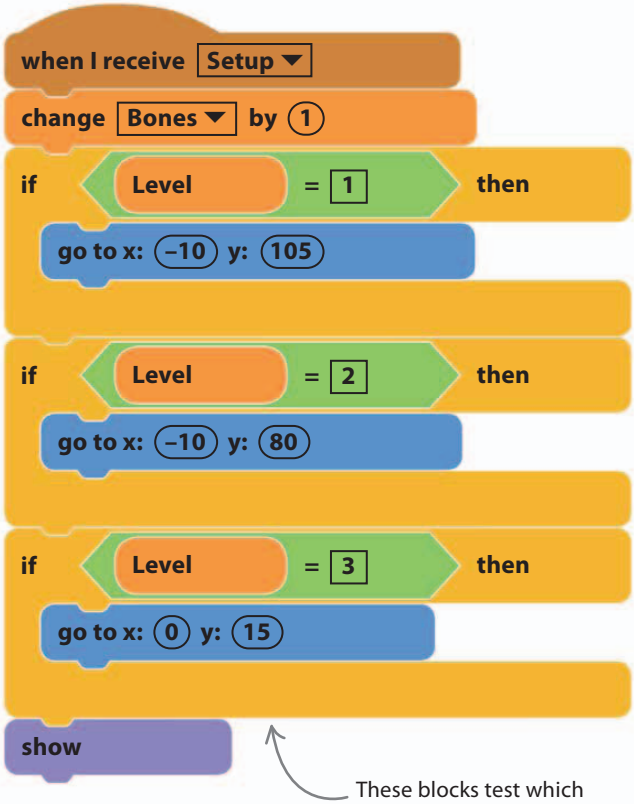
46 The game needs more than one bone, so right-click on the Bone1 sprite and select "duplicate". Do this twice. This will give you three bone sprites.





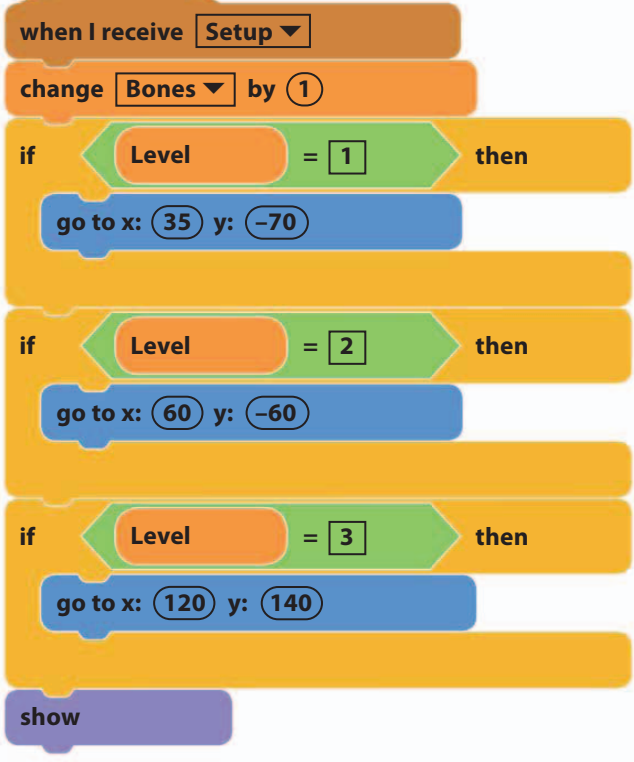
47 You need to change the "Setup" scripts for Bone2 and Bone3 so that they appear in different places from Bone1 on each level. Change the numbers in the "go to" blocks to match those shown here.

BONE 2



These blocks test which level the bone is on and set its position on the stage.

BONE 3

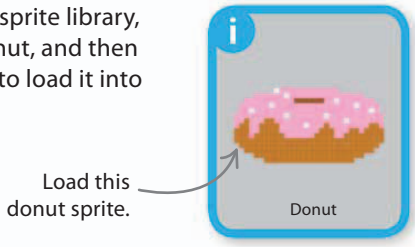


48 The bones' scripts manage the number of bones on a level automatically. Run the project. You should find that the portal won't open until you've collected all three bones.

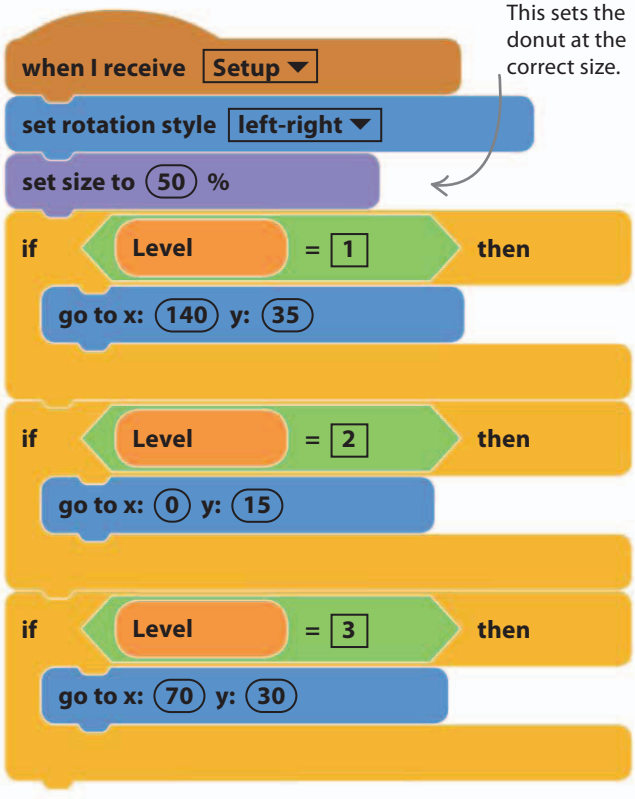
Junk food

The dog is having a rather easy time of it with all those bones to eat. Adding some obstacles and hazards will make the game more difficult. Start with the flying donut.

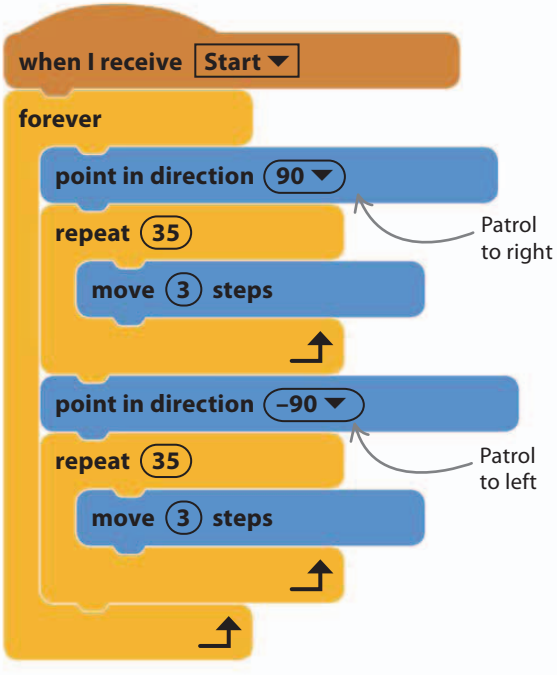
49 Go to the sprite library, select Donut, and then click "OK" to load it into the game.



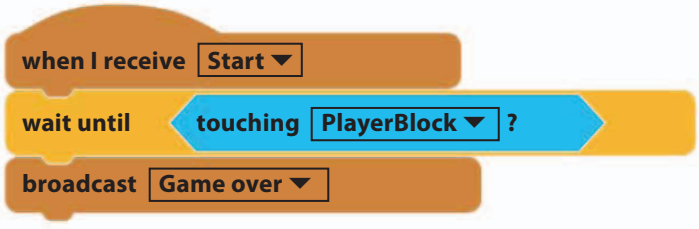
50 Now add this "Setup" script to shrink and position the donut for each level.



51 Next, add this "Start" script to get the donut patrolling back and forth.



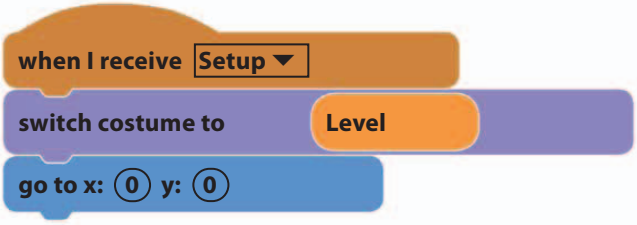
52 Add one last script to detect a collision with the PlayerBlock and end the game—junk food really is bad for you!

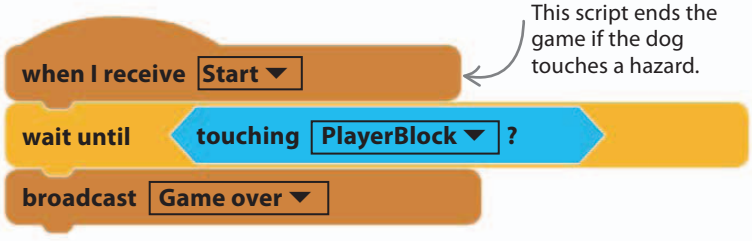


53 Now run the game and try getting past the donut. If you hit the donut, the dog will stop and howl.

Hazardous snacks

As well as the flying donuts there are a number of fixed traps on the levels. To keep things simple, all these hazards are part of a single sprite with three different costumes—one for each level.

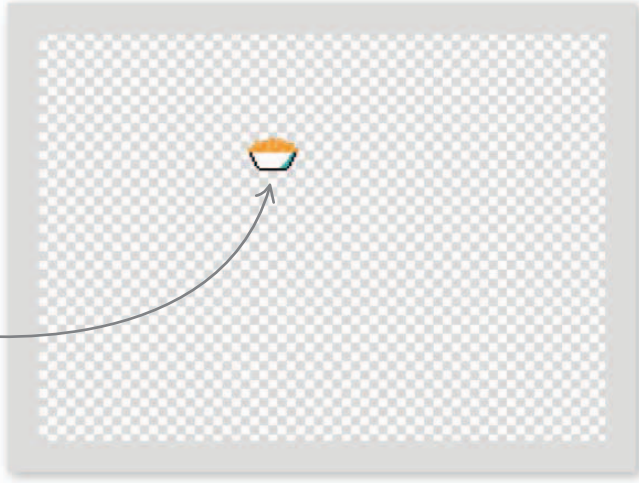




This script ends the game if the dog touches a hazard.

54 Create a new blank sprite called "Hazards" and add the two scripts shown here. The "Setup" script selects the correct costume for the level and centers it on the stage (just like in Platforms). Click on the "Setup" script to center the sprite before you design its costumes.

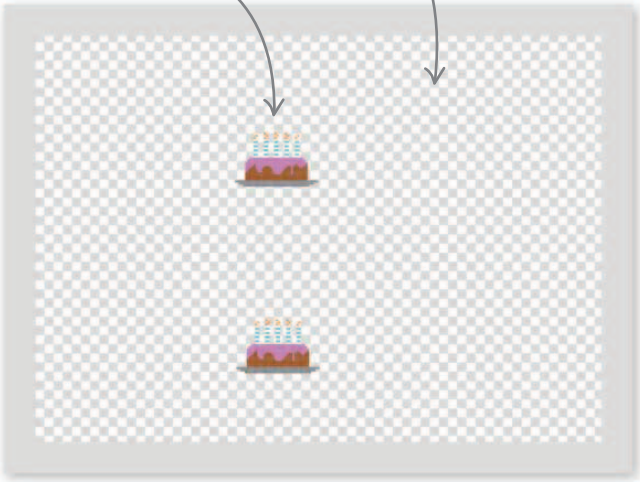
55 You need three costumes for the Hazards sprite. Use the paintbrush symbol to create two extra blank costumes. Select "costume1" and click the "Add" button at the top. Load the "cheese puffs" costume from the library. Use the "Select" tool to make it smaller and position it as shown here. Then, from the costume library, add two cakes to "costume2" and one to "costume3". Make them smaller and position them. You can fine-tune their positions later.

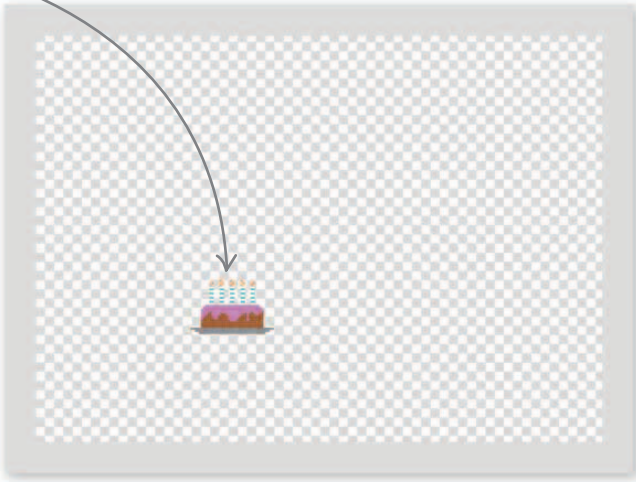


Most of the costume should have the checked pattern for a see-through color.

Use two cakes in Level 2.

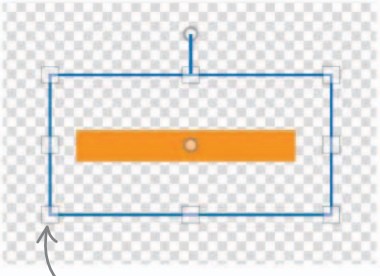
Use one cake in Level 3.





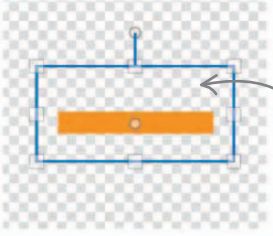
Fine-tuning

Now that your platforms, portals, bones, and hazards are all in roughly the right place, run the project and see if the game works. You might find that some sprites aren't positioned correctly. The game might be too tricky or the dog might get stuck. If so, you need to fine-tune your levels. The hints and tips here will also be handy if you want to design new levels.



Click and drag the small squares to stretch and resize the selection.

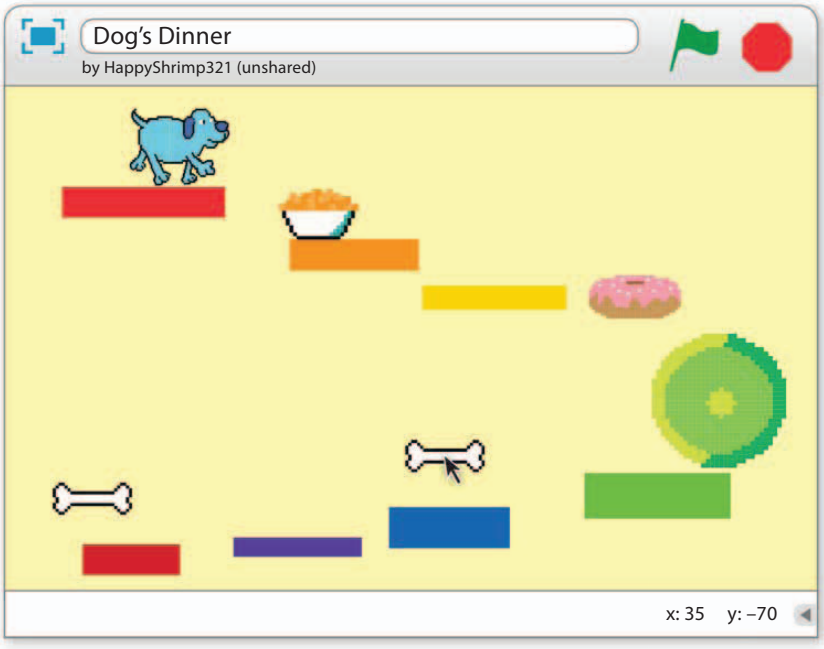
56 Most problems can be fixed by adjusting the positions and sizes of the platforms. Select the Platforms sprite and click the Costumes tab. Use the "Select" tool in the paint editor to move, stretch, or resize the Level 1 platforms. Click outside the selection box to show your changes on the stage. Adjust the platforms until Level 1 matches page 145.



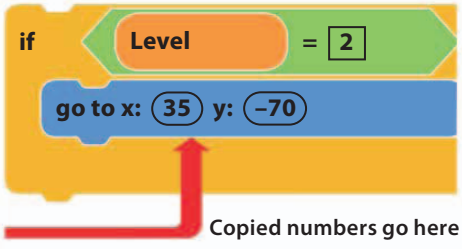
To move a platform, click inside the selection and drag.

57 Use the same method to fine-tune the position of the Hazards sprite. Select it in the sprites list and click on the Costumes tab. Use the "Select" tool to adjust the position of the snack in the first costume (which appears in Level 1). Click outside the selection box to check your changes on the stage.

Fine-tune the cheese puffs using the "Select" tool.



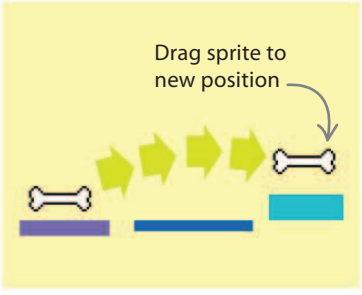
58 You can reposition all the other sprites by using their x and y coordinates. Select a sprite on the stage and drag it where you want. Hover the mouse-pointer over the center of the sprite and make a note of the x and y numbers that appear under the stage. Copy the numbers into the blue "go to" block in the sprite's Level 1 script.

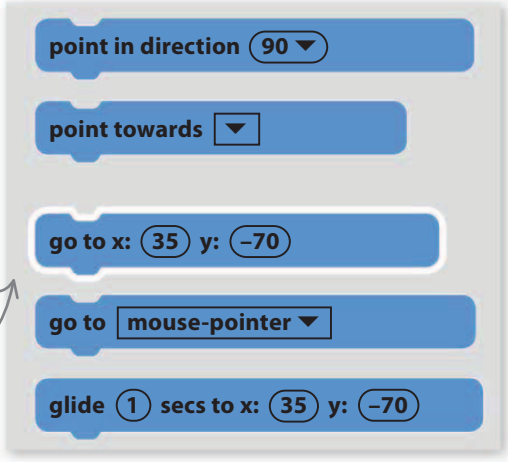


EXPERT TIPS

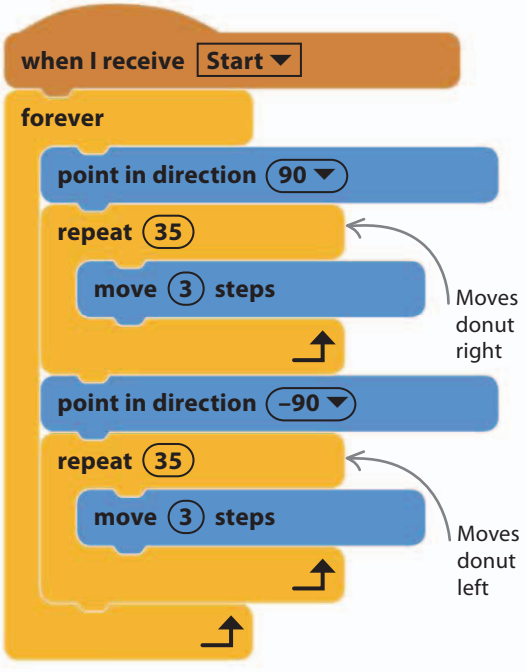
The "go to" trick

To reposition a sprite perfectly, use this sneaky trick. First drag the sprite on the stage to where you want it. Then look at the unused "go to" block in the Motion section under the Scripts tab. The sprite's coordinates will have appeared automatically in this block. Now you can simply drag the block into your script without needing to do any typing. Easy!

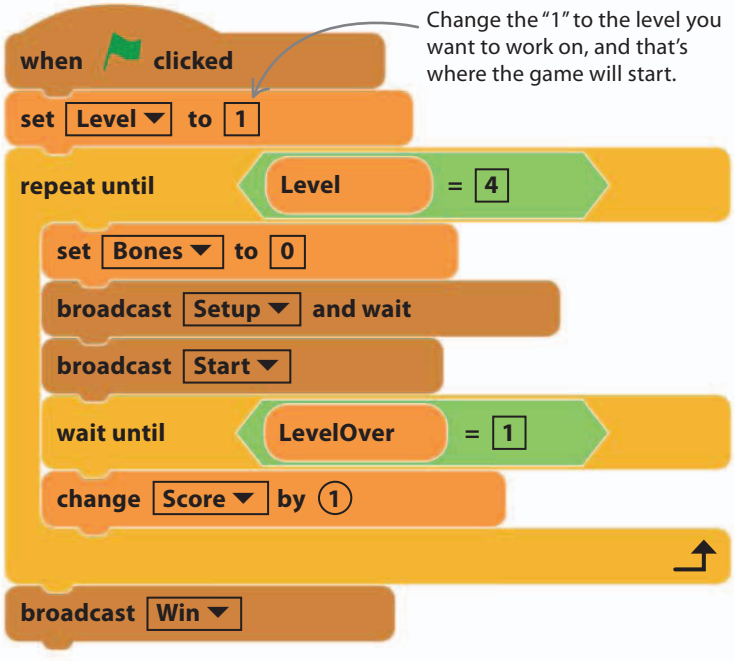




59 If you need to move the sliding donut, bear in mind that the "go to" block sets its start position. To change how far it slides, adjust the numbers in its two "repeat" loops. One controls how far it goes to the right, the other to the left.



60 You should now have Level 1 working beautifully. To work on another level and its sprites, you can make a temporary change to the script for the Game Control sprite. Change the number in the "set Level to" block to "2". Run the game and Level 2 appears on the stage. Fine-tune your sprites' positions. But remember to change the number in "set Level to" back to "1" when you're done.

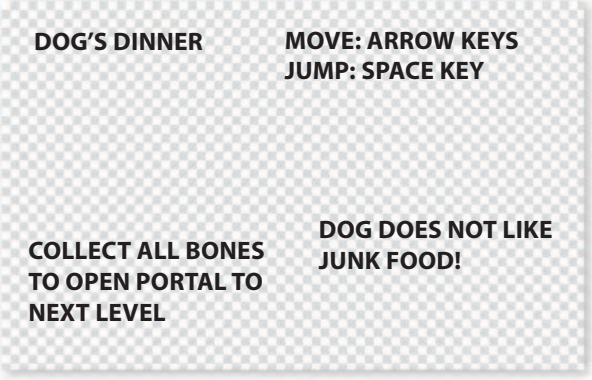


Signs and music

The game won't be complete until you've added some instructions and other messages for the player. You can also load some music into it to make it even more entertaining.

61 To give instructions and other messages to the player, use the paintbrush symbol to create a new blank sprite and call it "Signs". Add the costumes below to the Signs sprite. Name them "Instructions", "Win", and "Lose".

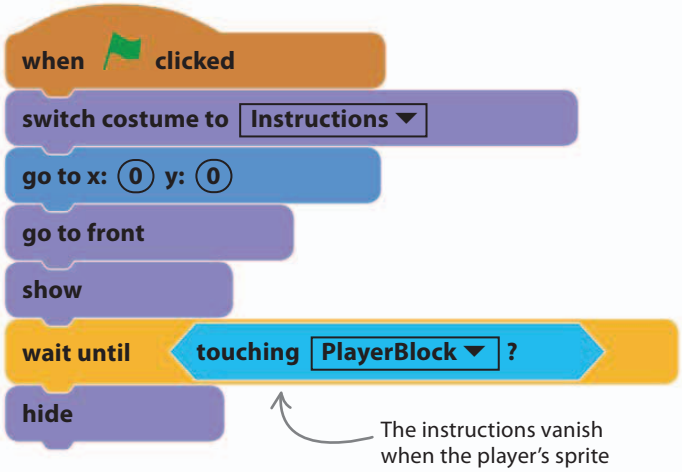
Instructions



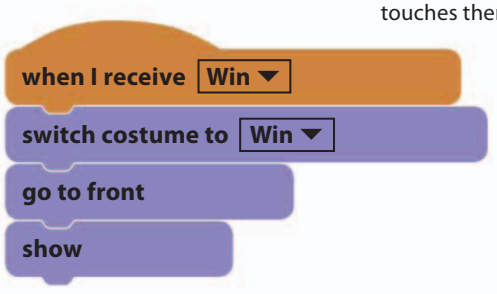
Win

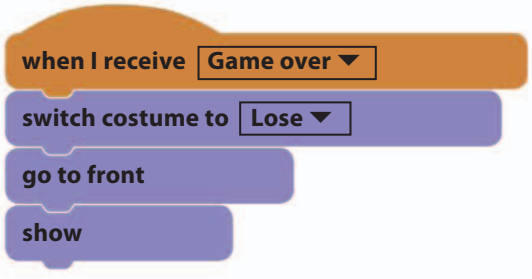
Lose

62 To show the correct sign to the player when the Signs sprite receives a message, add the three scripts below. Run the project to check that the correct signs show as you play.

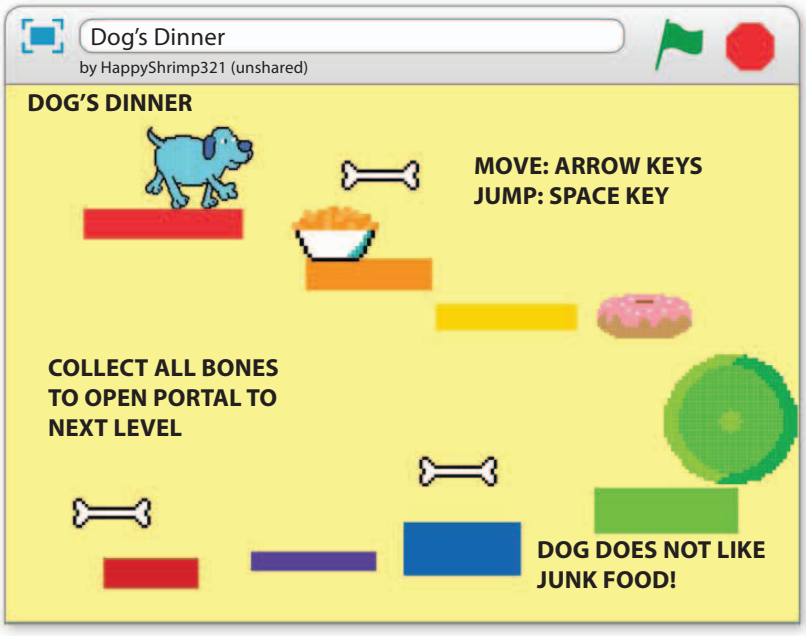


The instructions vanish when the player's sprite touches them.



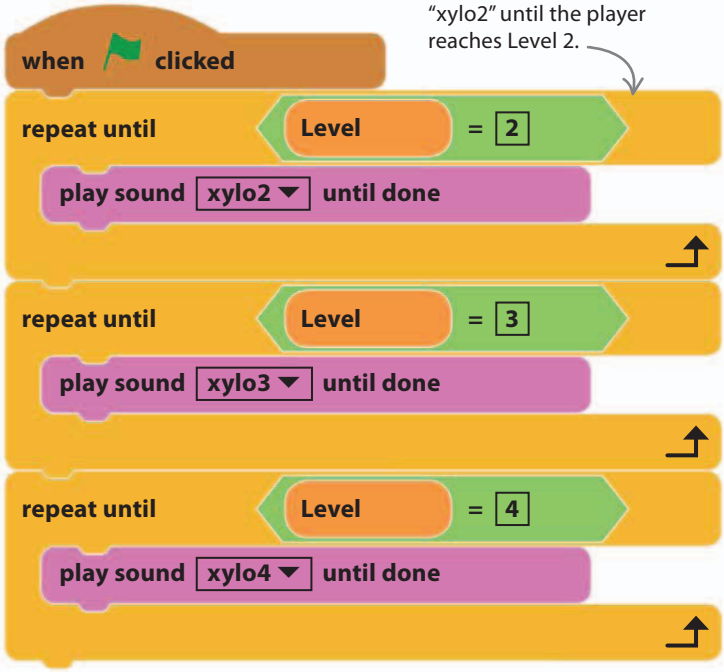


63 Check the positions of the instructions. You may need to rearrange them so that they don't overlap the images on the stage.

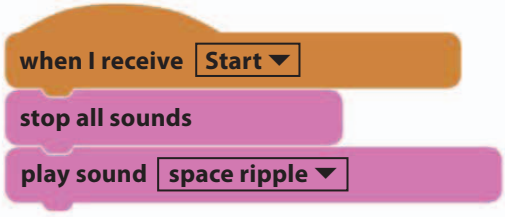


64 You can give each level its own music. Select the Game Control sprite and load these sounds from the Scratch sound library: "xylo2", "xylo3", and "xylo4". The script below will swap the music each time you change level.

The first "repeat" loop plays "xylo2" until the player reaches Level 2.



65 Add the next script to the Game Control sprite to swap the music at the moment the new level starts and to announce the start of each level with a sound effect. Load the "space ripple" sound into the sprite.



66 To play a victory tune when the dog finishes the final level, load "triumph" from the sound library and add this script to the Game Control sprite. Run the game. Check that the music changes for each level, and that sound effects play at the start of each level and at the end of the game.

Hacks and tweaks

Congratulations, your platform game is up and running! Test it and ask your friends to play it. You may need to adjust the sprites' positions and edit your platforms and hazards a little to make the game play smoothly and to get the difficulty level just right.

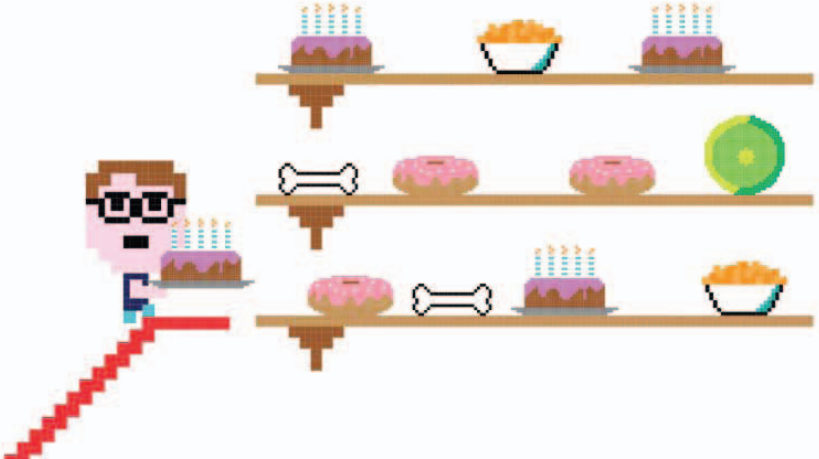
EXPERT TIPS

Backing up

Save a backup copy of the game under a different name before you start making changes. If you do this, you'll always have the copy to go back to if you make mistakes when tweaking the code. To save with the online Scratch editor, select the File menu and click on "Save as a copy".

▽ **Victory dance**

If you think the end of the game isn't exciting enough, change the script for the "Win" message to do something more spectacular. Maybe the dog could do a little victory dance? Why not add a new sign for when the dog falls off the platforms and ends up at the bottom of the stage? You could make the dog disappear too.

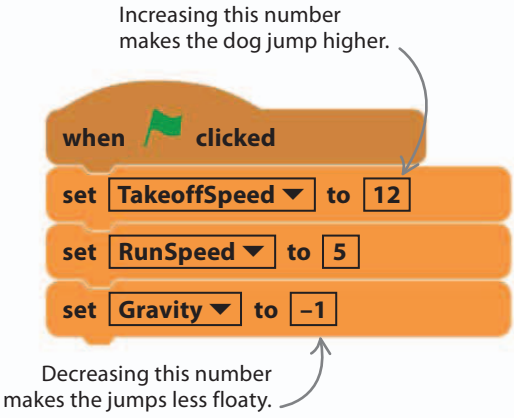


◁ **Extra levels**

To make the game longer you could create extra levels. You would have to give the Platforms and Hazards sprites more costumes, and edit the scripts to add "if Level =" blocks to place the bones, portal, and donut at the start of each level. Don't forget to change the "Level = 4" block in the Game Control sprite's loop, so that the game will end after the player has completed all the new levels.

▷ Mega-challenge

Can you figure out how to give the dog a limited number of lives? You'd need a new variable called "Lives", and you'd have to reprogram all the "Game over" messages to subtract 1 from the variable until you reach the last life. The Game Control sprite's loop would also need changing. It's an expert programming challenge that needs clear thinking and hard work!



◁ Adjust the jump

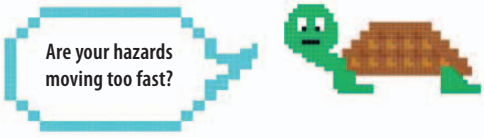
You have total control over the dog's jumps. You can make him leap higher by increasing the value of the "TakeoffSpeed" variable. You can also make the value of "Gravity" smaller or larger to control how much each jump floats. Why not add a special level with reverse gravity, so that gravity pulls you up, not down? You will need to make code changes to set the jump variables just for that level with an "if then" block, and also to detect when the dog "falls" off the top of the level!

GAME DESIGN

Designing levels

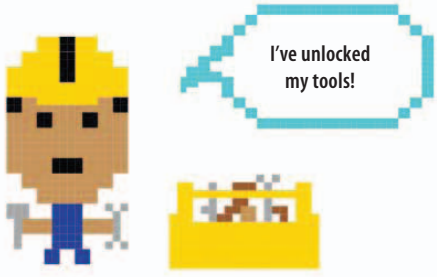
Designing how all the challenges and rewards in a level fit together is a tricky job. You need to plan every detail and get a friend to test it to see if it's too easy or too hard. Make sure you can complete the level yourself before asking the friend to try.

Timing Are your moving hazards going so fast you can't get past them, or so slow there's no challenge? Adjust their speeds until you're happy with them.



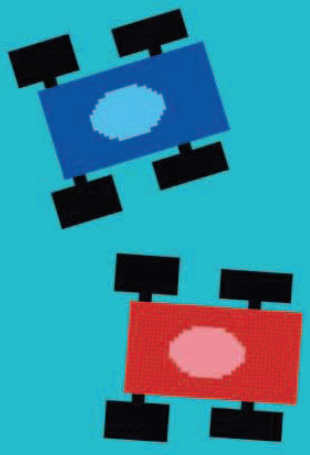
Spacing Is the player able to jump from platform to platform easily—or perhaps too easily? Make the gaps between the platforms bigger or smaller to suit the level you're designing.

Tricks Try fooling the player into following what appears to be an obvious way through a level but then turns out to be a trap. The correct way will be an easier but less obvious, solution.



Tools Computer games often come with level design tools that are unlocked once you finish the game. Using these you can create your own challenges and puzzles within the game. You can usually share your customized levels online, so that others can try them.

Glacier Race

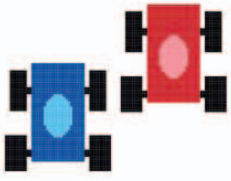


How to build Glacier Race

Glacier Race is a two-player game in which you race up the screen, swerving around obstacles and collecting gems as you go. There's no finish line in this race—the winner is simply the person with the most gems when the time runs out.

AIM OF THE GAME

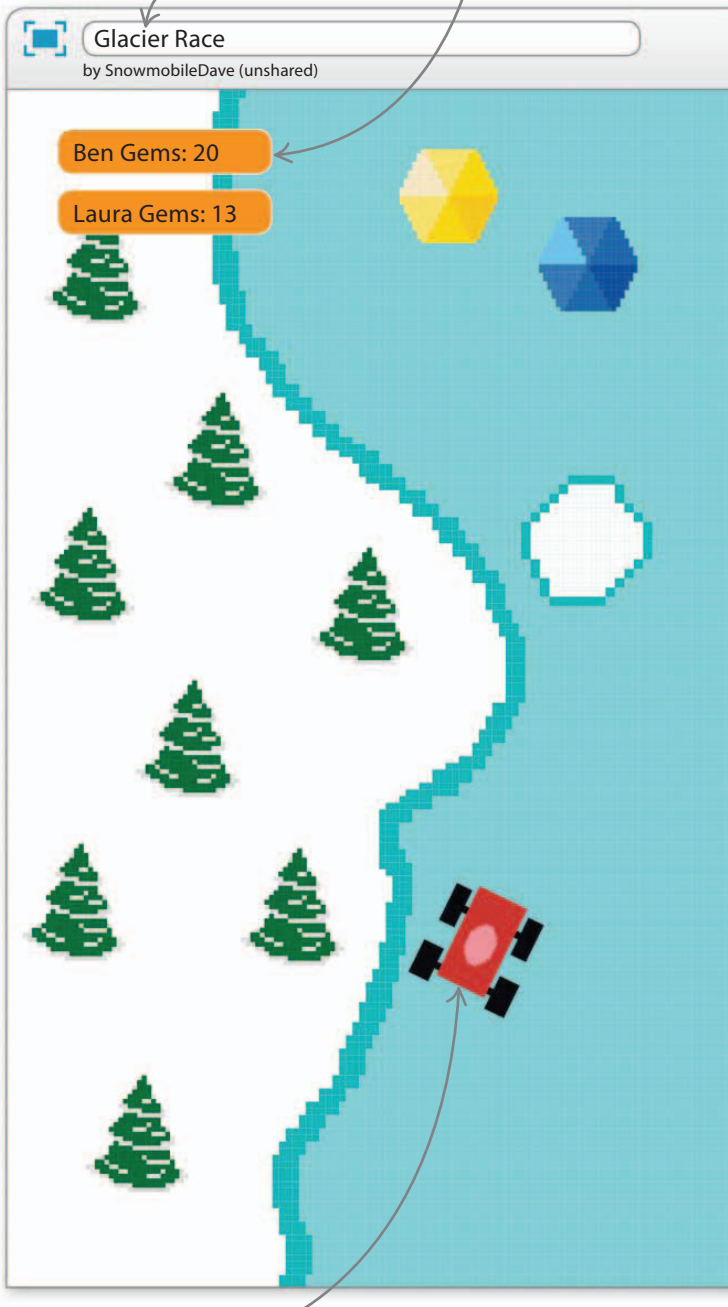
It's red car versus blue car in a race against the clock. Win by collecting more gems than your opponent before the countdown ends. Every gem you grab adds an extra second to the race countdown, but stay clear of the snow or you'll end up in a spin.



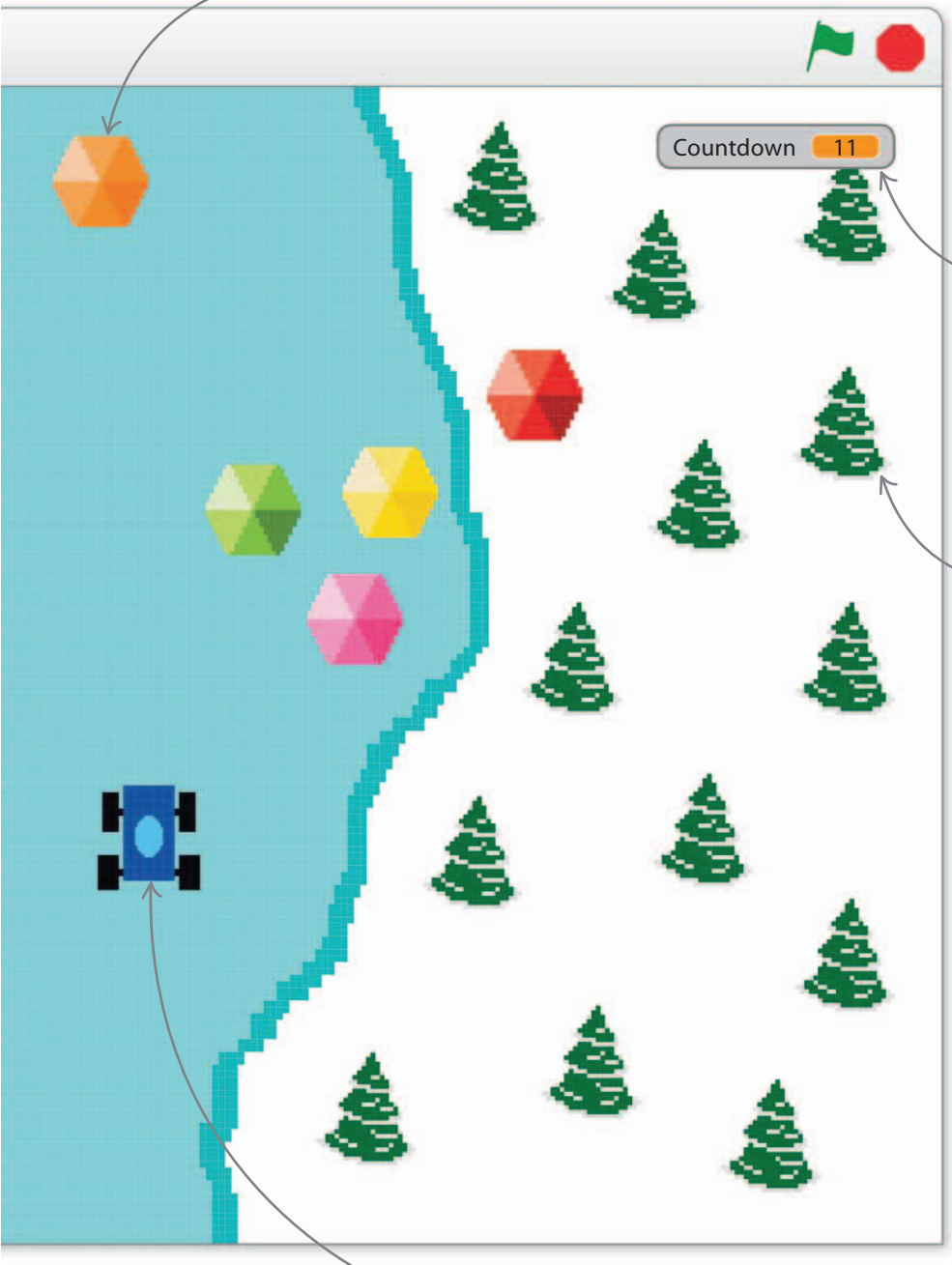
◁ **Cars**
Use the game controls to keep your car on the ice and collect gems. You can also push the other car off the road to gain an advantage.

◁ **Obstacles**
Avoid the giant snowballs and the edge of the road or you'll spin out of control.

◁ **Penguin**
The penguin is the master of ceremonies. He asks the players' names at the start, gives instructions, and announces the winner at the end.



Collect gems to score a point and add a second to the countdown so you can race a little longer.



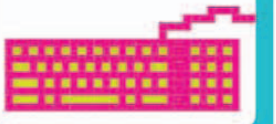
The countdown starts with 20 seconds. When it reaches zero the game ends.

Snowy hills and trees whiz past as the cars race.

The blue car starts on the right and is controlled with the arrow keys.

GAME CONTROLS

Use the arrow keys and the W, A, S, and D keys on the keyboard as game controls.

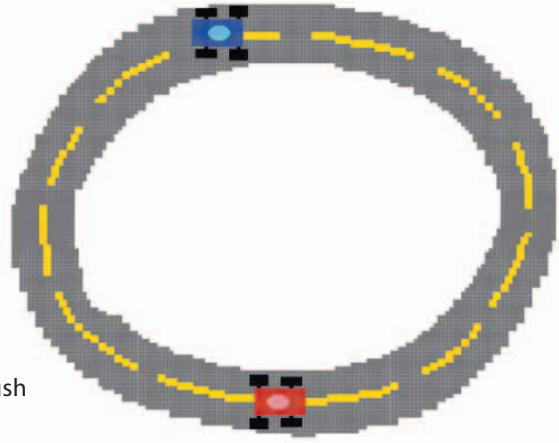


◁ **Icy adventure**

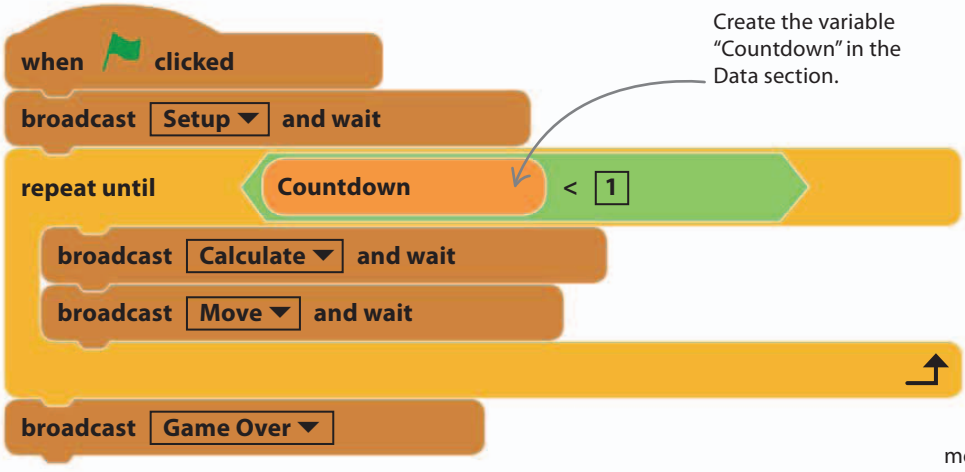
This fast-paced racing game is more fun because you play against an opponent. Challenge a friend or family member to see who can collect the most gems.

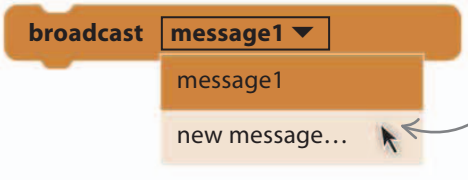
The game loop

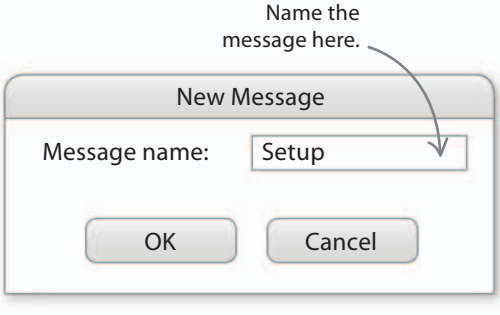
Fast games need clever code. This game uses something called a "game loop" to keep all the action happening just when it should. It's as if the game loop bangs a drum, and with each beat all the other sprites move one step. Start by creating a blank sprite to hold the game loop's script.



1 Start a new project and delete the cat sprite. Use the paintbrush symbol / to create a blank sprite and rename it "Game Loop". Then make a variable for all sprites called "Countdown" for the game timer and show it on the stage. Build the following script to make the game loop. You'll need to create the messages "Setup", "Calculate", "Move", and "Game Over".

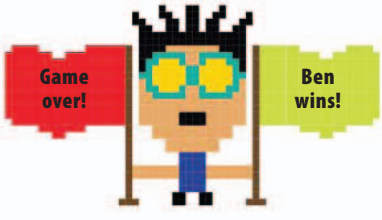






△ **How does it work?**

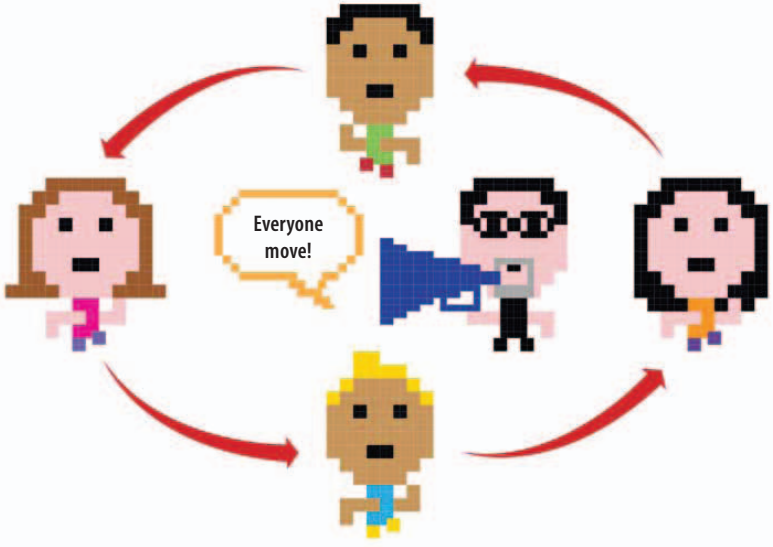
When the project runs, the script sends out a "Setup" message that tells all the sprites to get ready for the game. It waits for them to finish, and then the main loop begins. The loop sends out messages telling every sprite in the game when to run each part of their code. The loop ends only when the countdown reaches zero, at which point the "Game Over!" message is sent so all sprites can perform any final actions and the winner is announced.



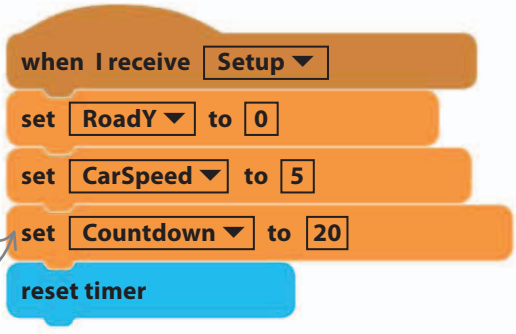
EXPERT TIPS

Game loops

Using one main loop to keep everything in sync is common in computer games. The loop keeps all the sprites in step and makes the code tidy and short. It also helps the game run quickly—in Glacier Race, the game loop runs as fast as 30 times per second. In Scratch, a program with lots of sprites each with their own loops can become slow as the computer has to constantly jump between them. Using a single game loop fixes this problem, but be careful not to use loops elsewhere in the game because they will slow it down.

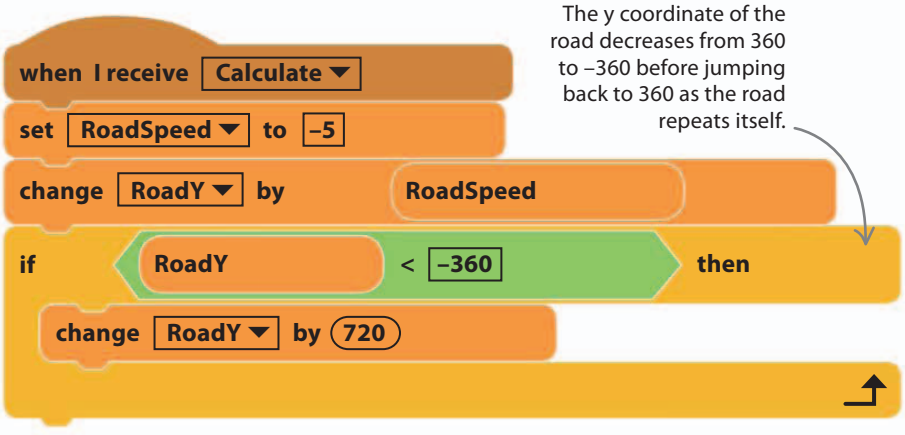


2 Create two new variables for all sprites: "RoadY" (to store the y coordinate used to position our moving scenery) and "CarSpeed" (to set how quickly the cars can move around the stage). Uncheck the boxes in the Data section so they aren't displayed on the stage. Add the script on the right to set the values of the variables at the start of the game.



This block sets the time limit for the game in seconds.

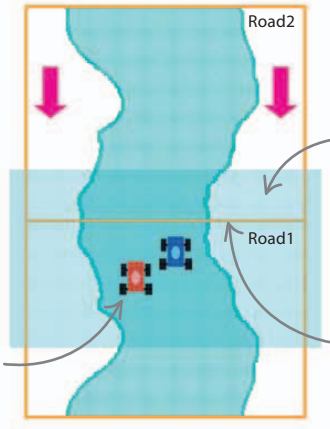
3 Add another variable for all sprites called "RoadSpeed" to store the speed of the moving scenery. Uncheck the box. Then create a script to calculate the position of the road each time the game loop runs. You'll see how this works once you've made the road sprites.



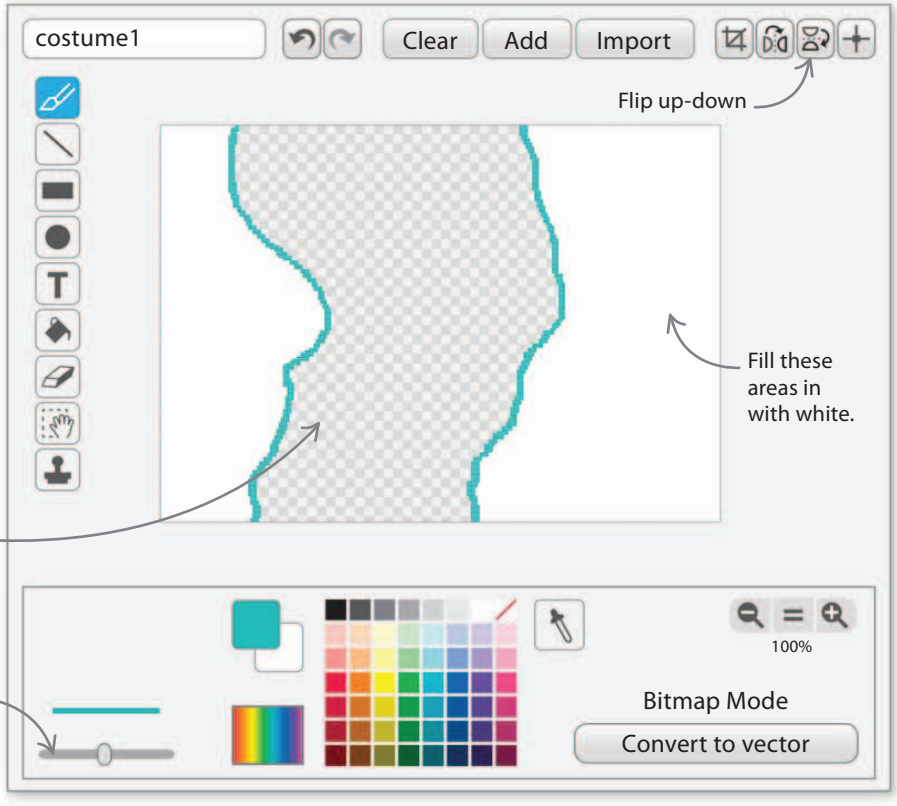
The y coordinate of the road decreases from 360 to –360 before jumping back to 360 as the road repeats itself.

Scrolling road

In Glacier Race, players feel as if they're moving quickly along the road, but in reality their cars don't move very far on the stage—it's the road that moves instead. The road is made up of two sprites that fit together seamlessly: Road1 and Road2. These roads take turns scrolling down the stage, making the cars appear to move faster than they really are.

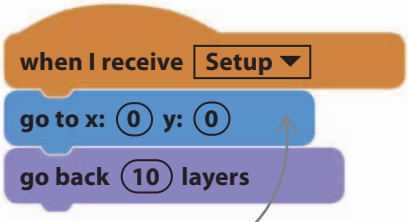


4 Create a new sprite and call it "Road1". In the paint editor, choose the paintbrush tool and set the thickness slider to the middle. Draw the edges of the road and make sure they run all the way from the top to the bottom without any gaps. Then use the fill tool to color the area on both sides of the road white, creating a snowy setting.

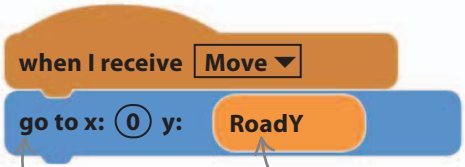


5 Now duplicate the Road1 sprite to make Road2. Select Road2 and go to the Costumes tab. Click on the "Flip up-down" button at the top right and the road costume will turn upside down. The edges of Road1 and Road2 will now match as they are mirror images. They'll look odd on the stage at the moment, but you'll fix that later.

6 Add these scripts to Road1 to get the road moving. They position the road using the "RoadY" variable in the game loop. Try running the project—half the road will scroll down the screen.



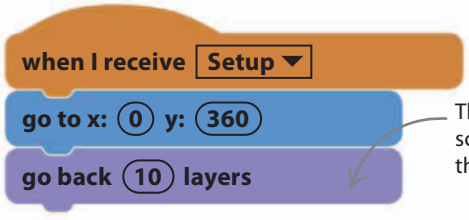
This block makes the game start with Road1 filling the stage.



This block makes Road1 change position when the Game Loop broadcasts the "Move" message.

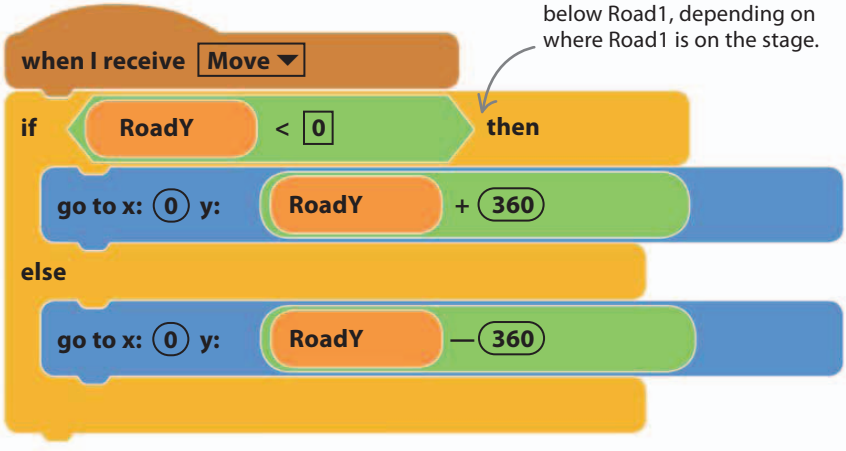
This variable is set in the Game Loop when the message "Calculate" is sent.

7 Now build the following scripts for Road2 to make the second road sprite work together with the first. Run the project—the road should scroll smoothly down the screen.



This makes sure the scenery stays behind the other sprites.

Road2 is positioned above or below Road1, depending on where Road1 is on the stage.



8 To add color to the road, paint the backdrop rather than the sprites, or else the cars will collide with the road surface. Select the stage and click on the Backdrops tab. Use the fill tool to fill it with an icy blue color.

LINGO

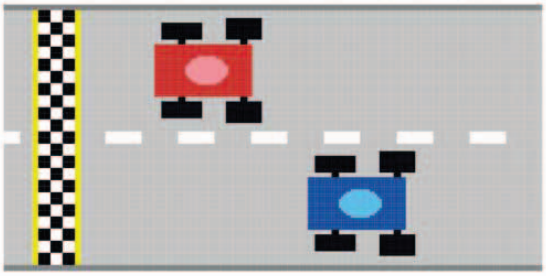
Scrolling

Moving everything on the screen together in the same direction is called scrolling. In Glacier Race, the road scrolls downward. You might have heard of games called side-scrollers, which means the scene moves left or right as the player moves the character on the screen.

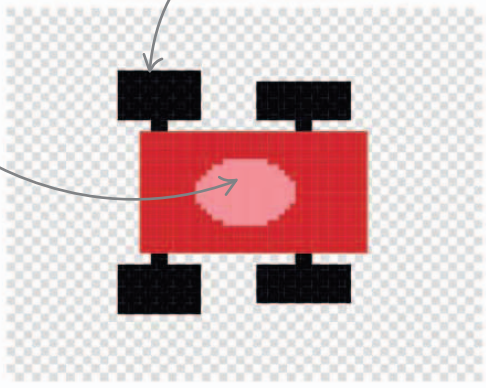
9 Make the scenery more interesting by adding some trees. Select Road1 and click on the Costumes tab. Click the "Add" button on top and add the tree costume. Shrink it by using the selection box and place it on the snow. Add as many trees as you like. Repeat the process for Road2.

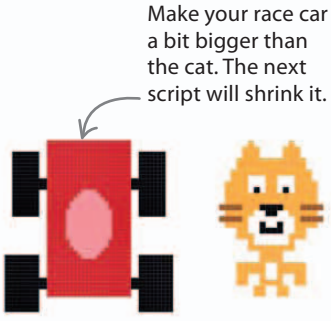
Racecars

Now it's time to add the racecars. Once you've got one car moving, you can duplicate it to make the second one and save yourself a lot of work.

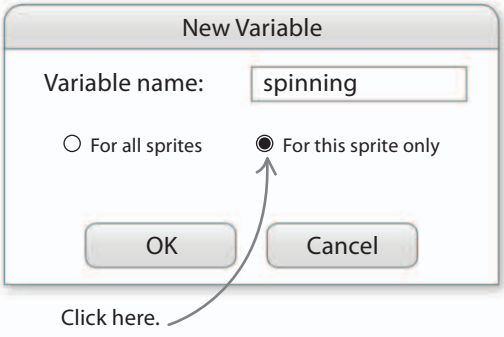


10 Click the sprite symbol and load Cat1 from the library—you can use this sprite to ensure the car is the right size. Now open the paint editor and click on "Convert to bitmap". Use the rectangle and circle tools to draw a car like the one shown here. Make sure you draw the car facing right or it will point the wrong way in the game. Remember to delete the cat image once you've finished and use the "Set costume center" tool to center the car.

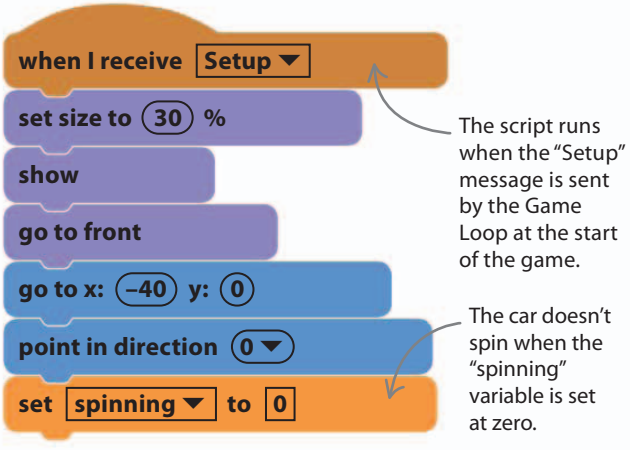




11 Rename the sprite "RedCar" in the sprites list. Then create a new variable, "spinning", which you'll use later to say when a car is in a spin. Note that for this variable, you need to select the option "for this sprite only" and uncheck the box in the Data section so that the variable doesn't show on the stage.



12 Remember that in this project, sprites can run scripts only when they get messages from the Game Loop. Add the following script to set up the red car at the start of the game.



13 You now need to add keyboard controls for the car. Choose More Blocks in the blocks palette and then click on "Make a Block". Create a new block called "car controls" and add this script to its "define" block.

The car usually points straight up the screen.

This block moves the car sideways.

This block makes the car turn a little to the right.

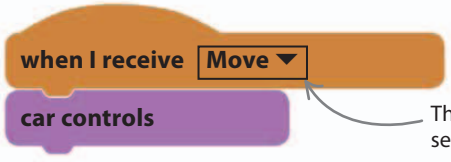
This block makes the car turn a little to the left.

This block moves the car up the stage.

This block makes the car appear to stop by moving it down the stage at the same speed as the road.

```
define car controls
point in direction 0
if key d pressed? then
    point in direction 30
    change x by CarSpeed
if key a pressed? then
    point in direction -30
    change x by 0 - CarSpeed
if key w pressed? then
    change y by CarSpeed
if key s pressed? then
    change y by RoadSpeed
```

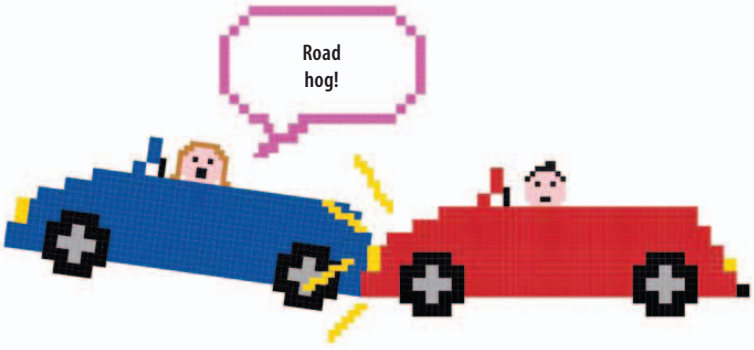
14 Add a script to run the "car controls" block when the car receives the message "Move" from the Game Loop. Run the project. You should now be able to steer the red car along the road using the keys W, A, S, and D.



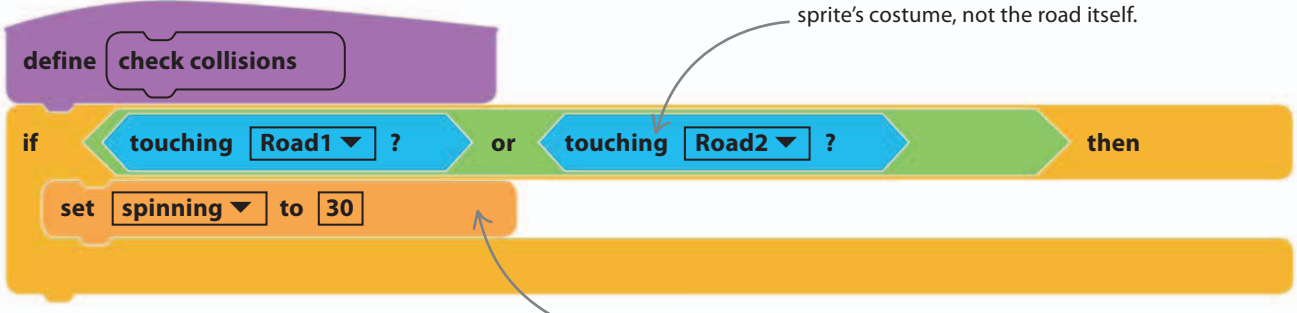
The "Move" message is sent by the Game Loop many times per second.

Collisions and spins

To make the game challenging, you can force players to avoid the snow by making their cars spin out of control if they touch it. You need to create some more new blocks to make this work.



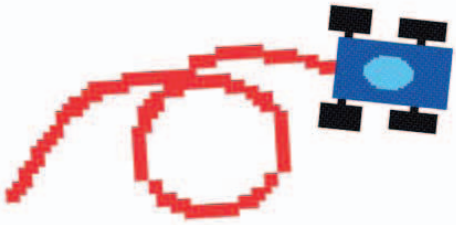
15 With RedCar selected, create a new block to detect the snow. Choose More Blocks in the blocks palette and then click "Make a Block". Name the block "check collisions" and create the following script.

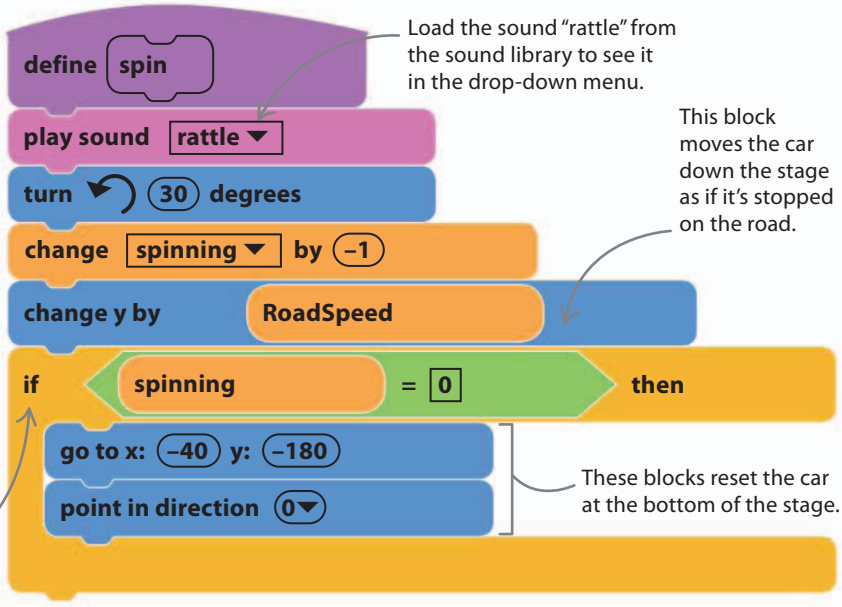


The "touching" block only detects the painted parts of the road sprite's costume, not the road itself.

This block tells the car how long to spin for.

16 Now create another block, call it "spin", and add the script shown here. The "spin" block runs when the car is spinning. It turns the car round and reduces the "spinning" variable by one. When the variable reaches zero, the spin ends and the car is reset at the bottom of the stage.





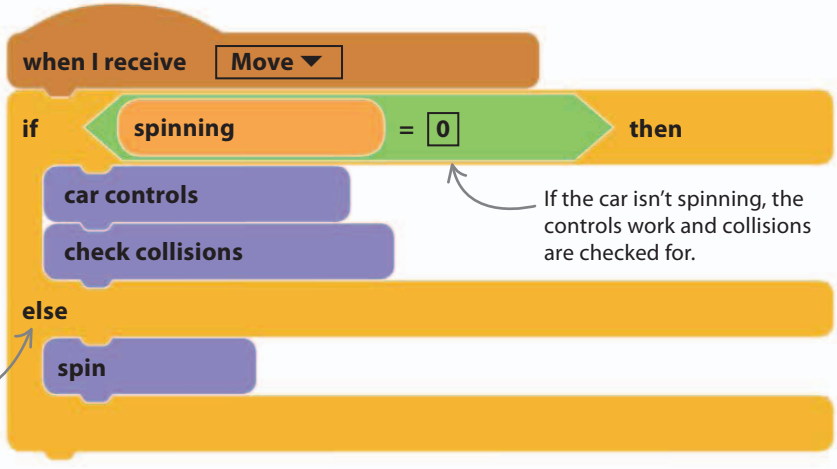
Load the sound "rattle" from the sound library to see it in the drop-down menu.

This block moves the car down the stage as if it's stopped on the road.

These blocks reset the car at the bottom of the stage.

This block checks if the spin is over.

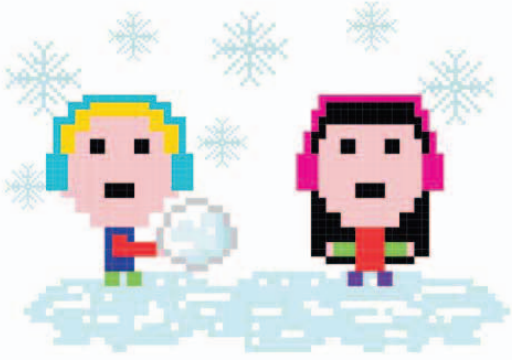
17 Finally, change the existing script triggered by the "Move" message to look like the one shown here. Now you can only control the car if the "spinning" variable is zero. Collisions are checked only when you're not in a spin—otherwise you'd spin forever! Run the game. The car should spin if it hits the snow.

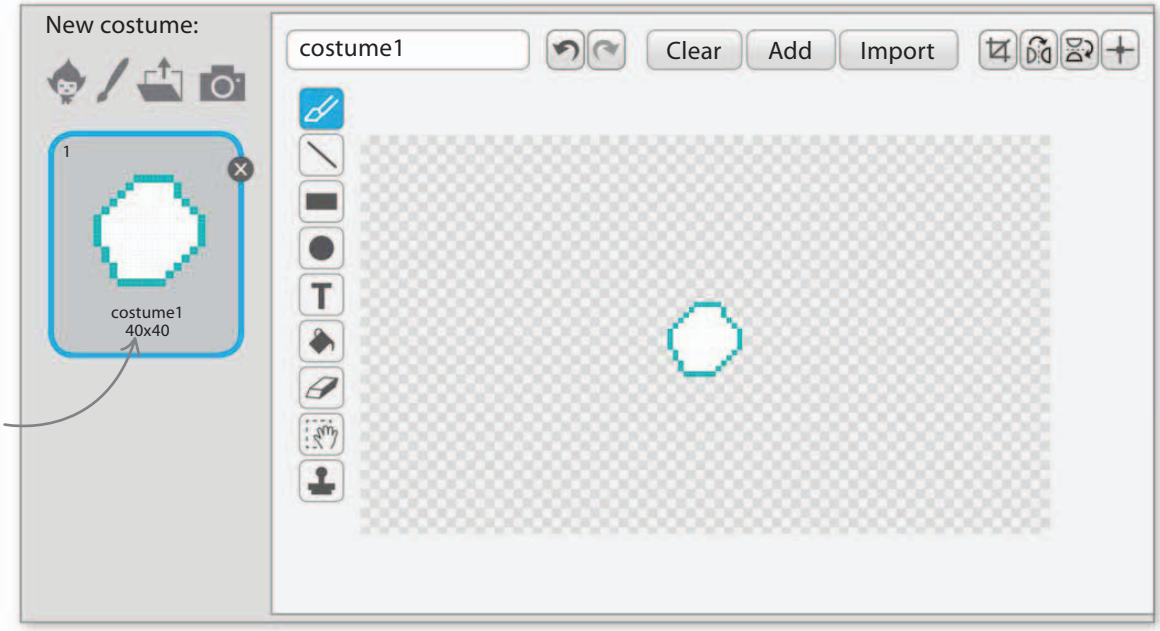


If the car isn't spinning, the controls work and collisions are checked for.

If the value for "spinning" is more than zero, the car will spin.

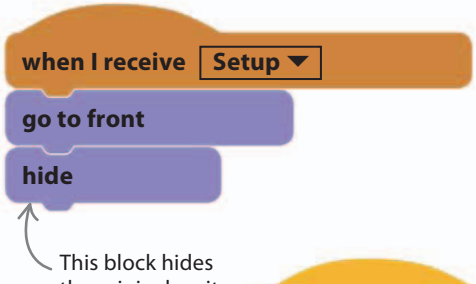
18 To add some snowball obstacles, create a new sprite in the paint editor. Make it about the size of the car on the stage. To get the correct size, watch it appear on the stage after you've drawn it. You can also see the costume's size in the costume list—aim for about 40x40. Name the new sprite "Snowball".



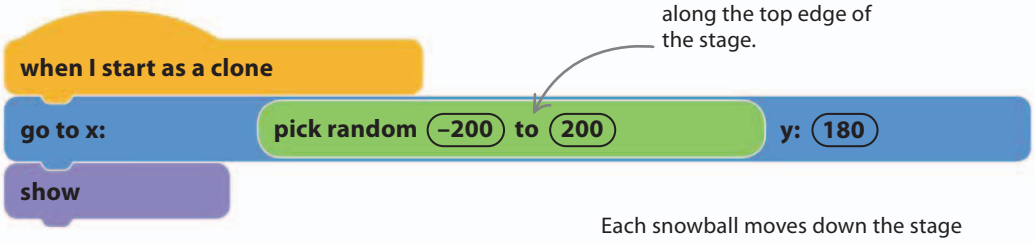


These numbers show the costume's size.

19 Add the following three scripts to the Snowball sprite. The Snowball sprite is cloned to make lots of obstacles, but you might notice that there's no "create clone" block here. The clones will be created by the Game Loop sprite, using some code that we'll add next.

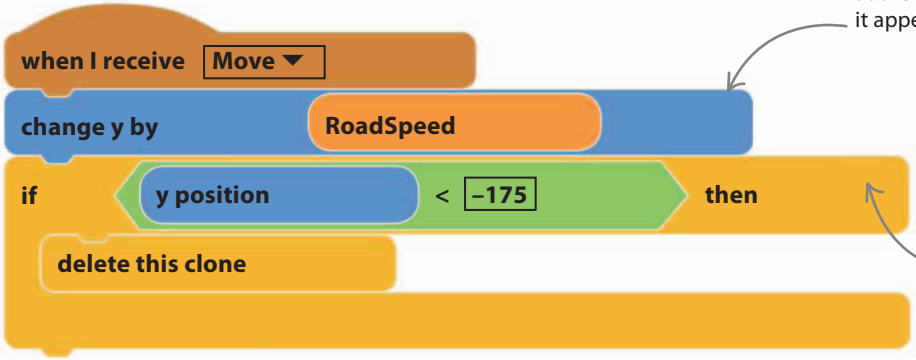


This block hides the original sprite so that you only see the clones.



The snowball clone starts at a random point along the top edge of the stage.

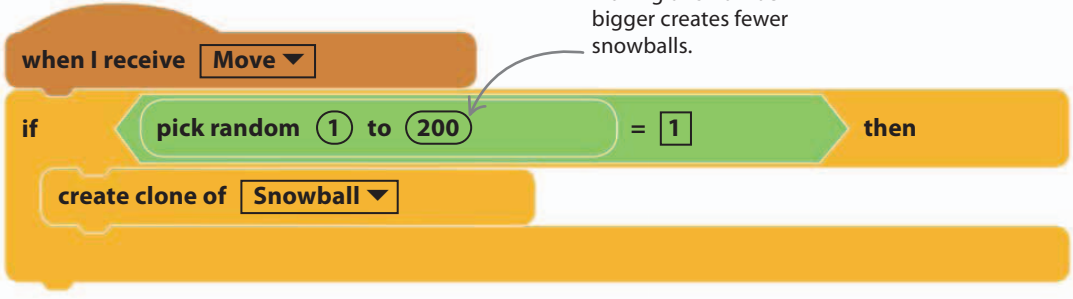
Each snowball moves down the stage at the same speed as the road, making it appear stationary.



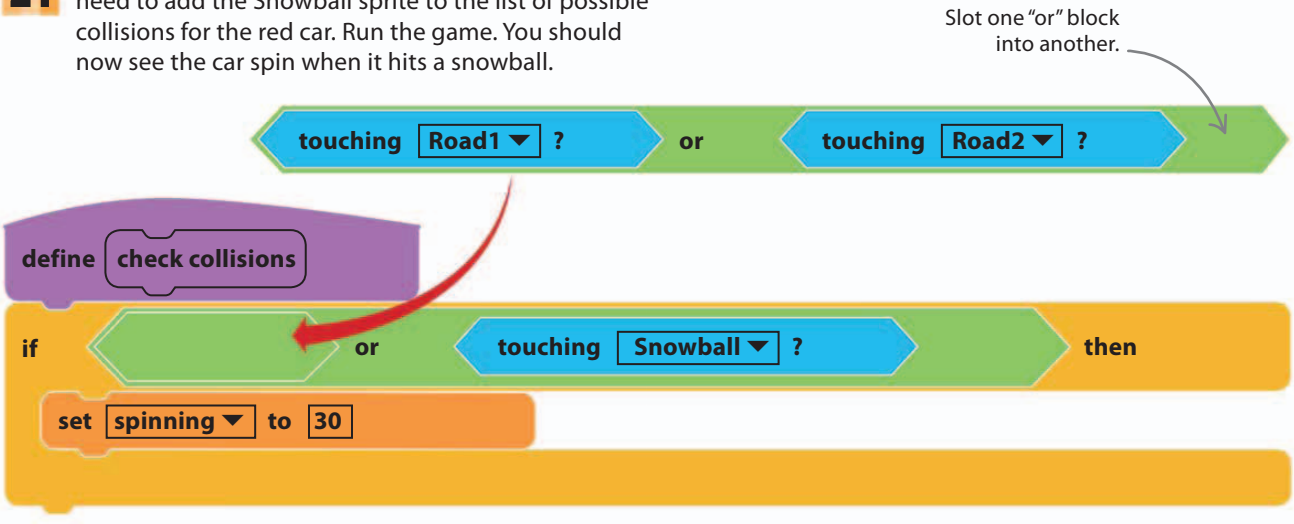
The snowball disappears when it reaches the bottom of the stage.

20 Now select the Game Loop sprite and add this script to make a new snowball appear with a chance of one in 200 every time the loop repeats.

Making this number bigger creates fewer snowballs.

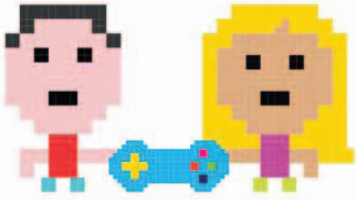


21 To make the car spin when it hits a snowball, you need to add the Snowball sprite to the list of possible collisions for the red car. Run the game. You should now see the car spin when it hits a snowball.

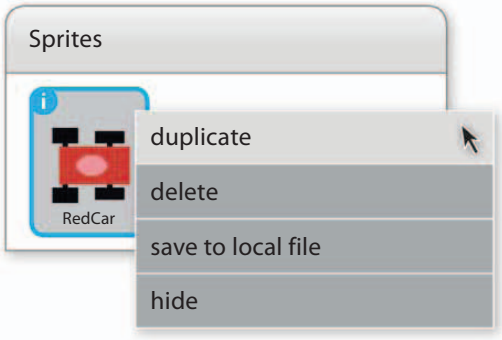


Player two

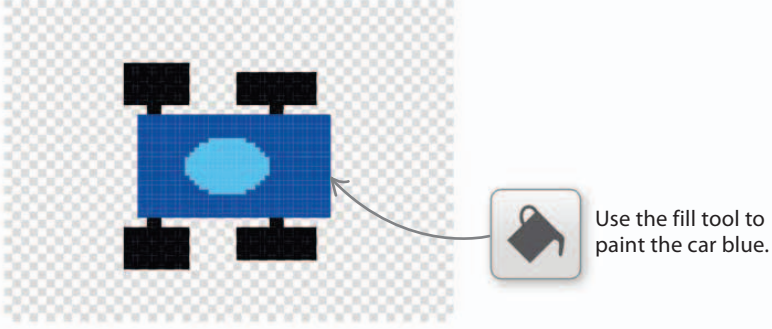
You now need to create the second player's car. Doing this is easy—you simply copy the first car, recolor it blue, and tweak the scripts.



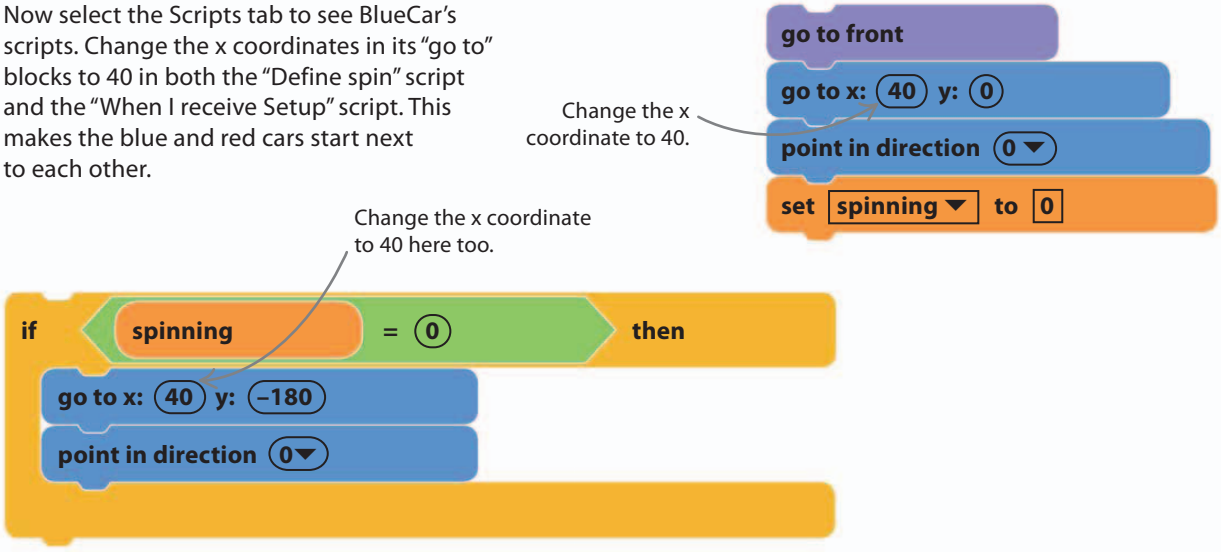
22 Duplicate the RedCar sprite and name the copy "BlueCar". Note that the duplicate sprite gets its own copy of all the scripts. This includes a copy of the "spinning" variable (set to "for this sprite only"), which can be different from the red car's.



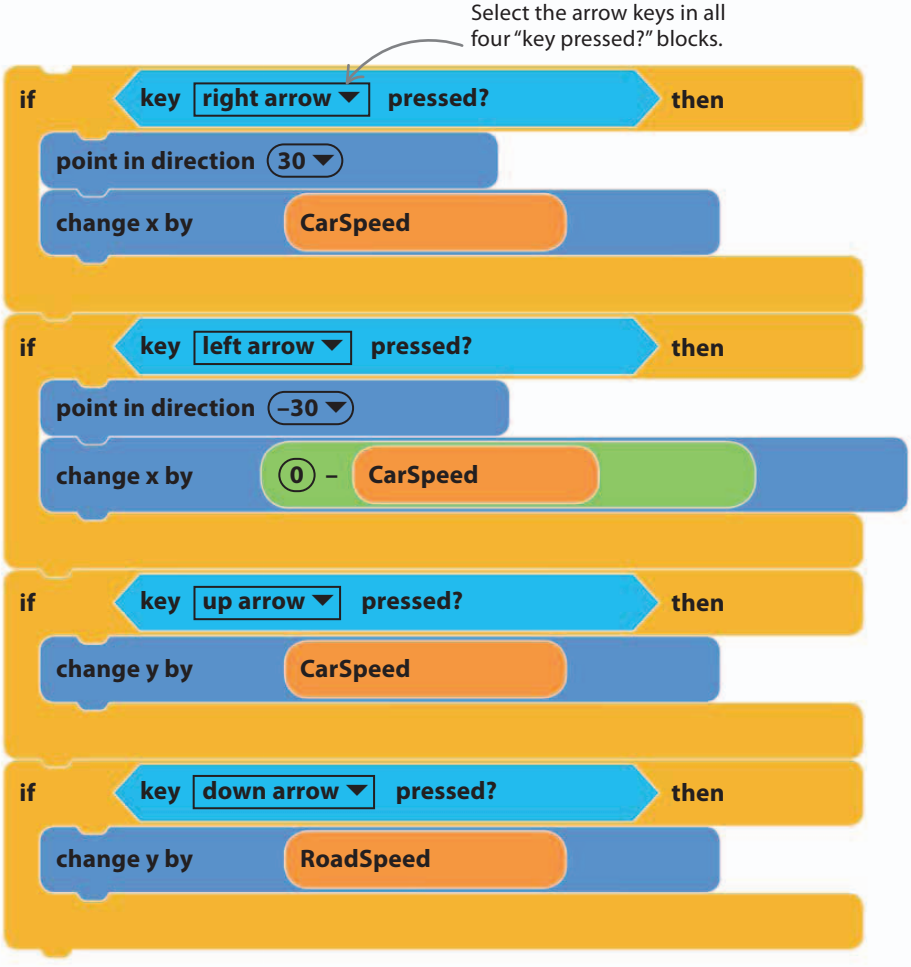
23 Select the BlueCar sprite and click on the Costumes tab to open the paint editor. Use the fill tool to change the color of the car.



24 Now select the Scripts tab to see BlueCar's scripts. Change the x coordinates in its "go to" blocks to 40 in both the "Define spin" script and the "When I receive Setup" script. This makes the blue and red cars start next to each other.



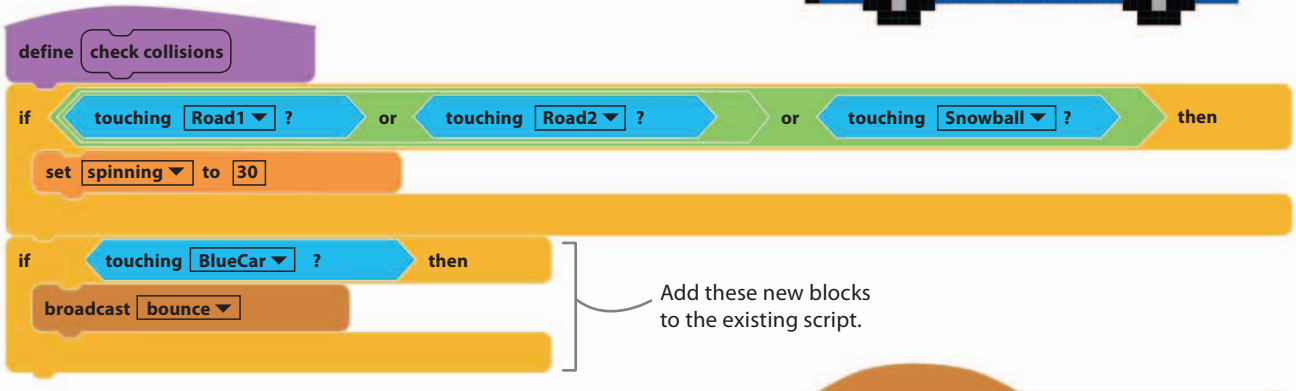
25 In the "Define car controls" script, change the "key pressed" blocks so that the blue car can be steered using the arrow keys on the keyboard. Then run the game. Both the cars should race along the track, but they can drive through each other at the moment.



▷ **Change the script**

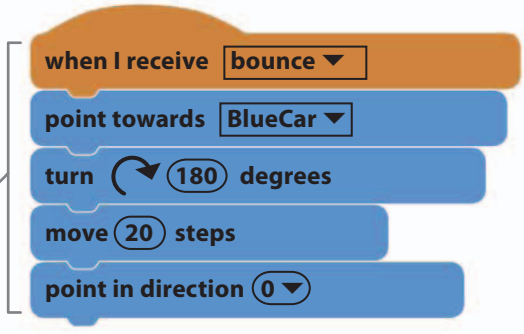
In the "key pressed?" blocks, replace key "d" with "right arrow", key "a" with "left arrow", key "w" with "up arrow", and key "s" with "down arrow".

26 To stop the cars driving through each other, you need to make them sense each other and then bounce apart. Add a new "if then" block to RedCar's "Define check collisions" script as shown here. Create the message "bounce", and then add a new script to make RedCar move away from BlueCar when it receives the message.

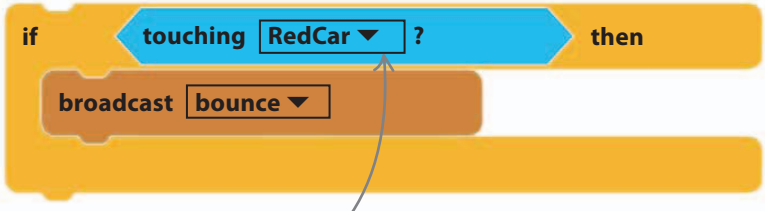


Add these new blocks to the existing script.

This new script makes RedCar bounce away from BlueCar.

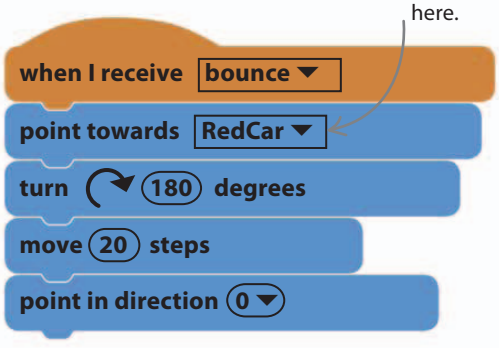


27 Now make the same changes to BlueCar's scripts so it can sense when it touches RedCar and bounce. Run the game to check the cars bounce when they collide.



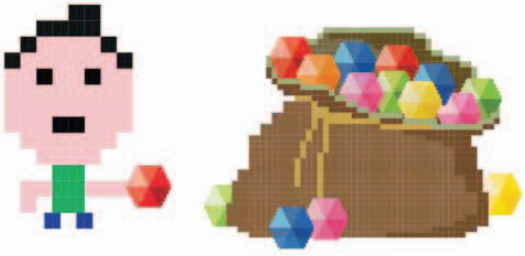
This time the "touching" block checks for collisions with the red car.

Choose RedCar here.

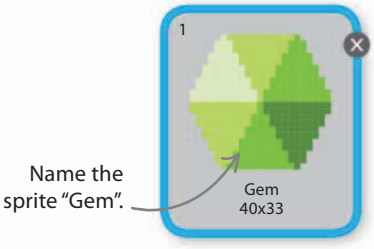


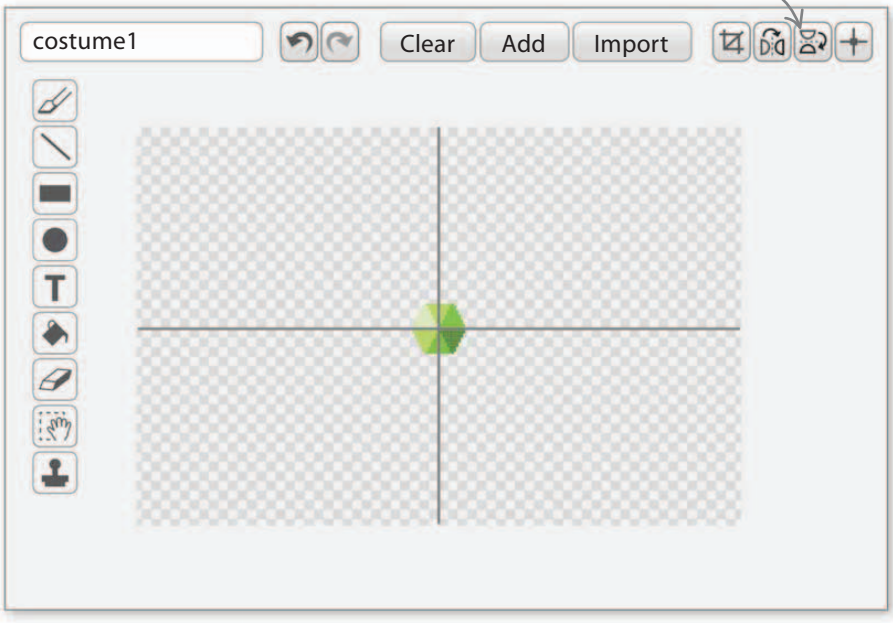
Collecting gems

The next step is to create the colorful gems that the players battle to collect. Each gem will be a clone of a single gem sprite, which makes it easy to put lots of gems on the stage at once.

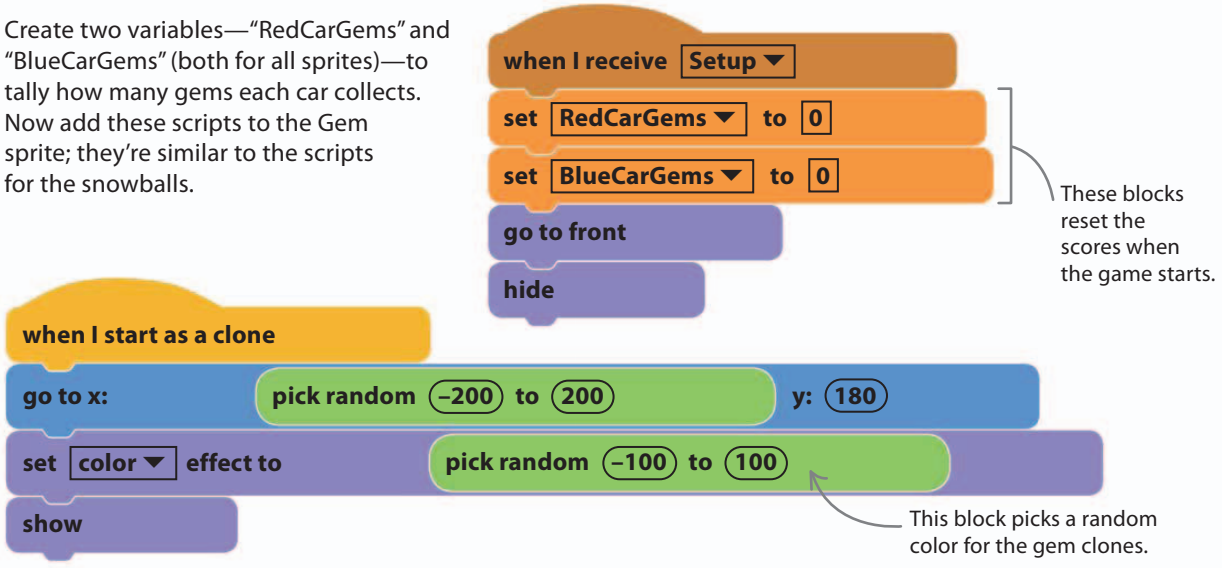


28 Click the paintbrush symbol in the sprites area to create a new sprite with the paint editor. To create a gem, use the line tool to draw six triangles arranged in a hexagon. Fill each one with a different shade of green. Make it similar in size to the snowball and center it when you've finished.

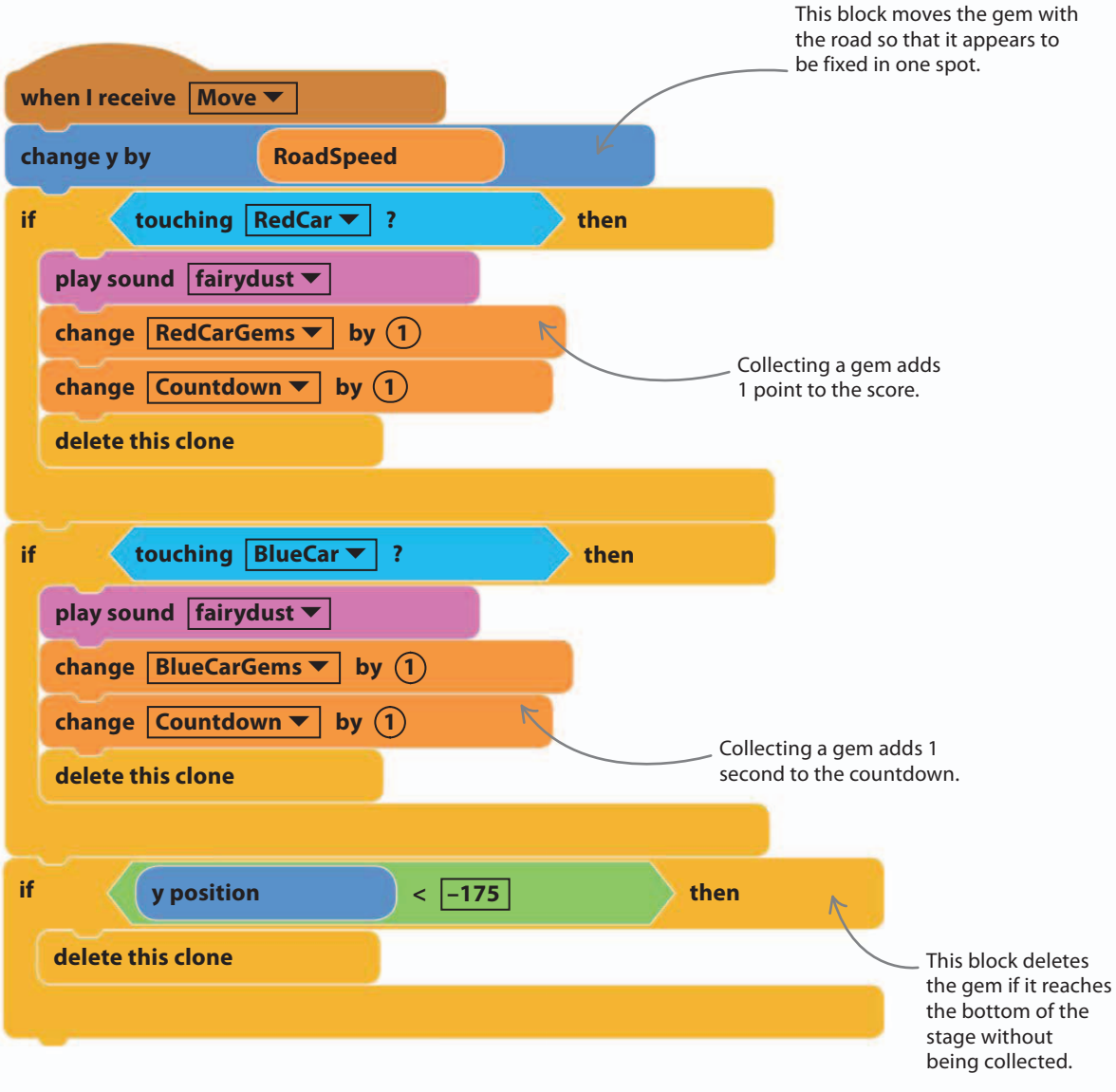




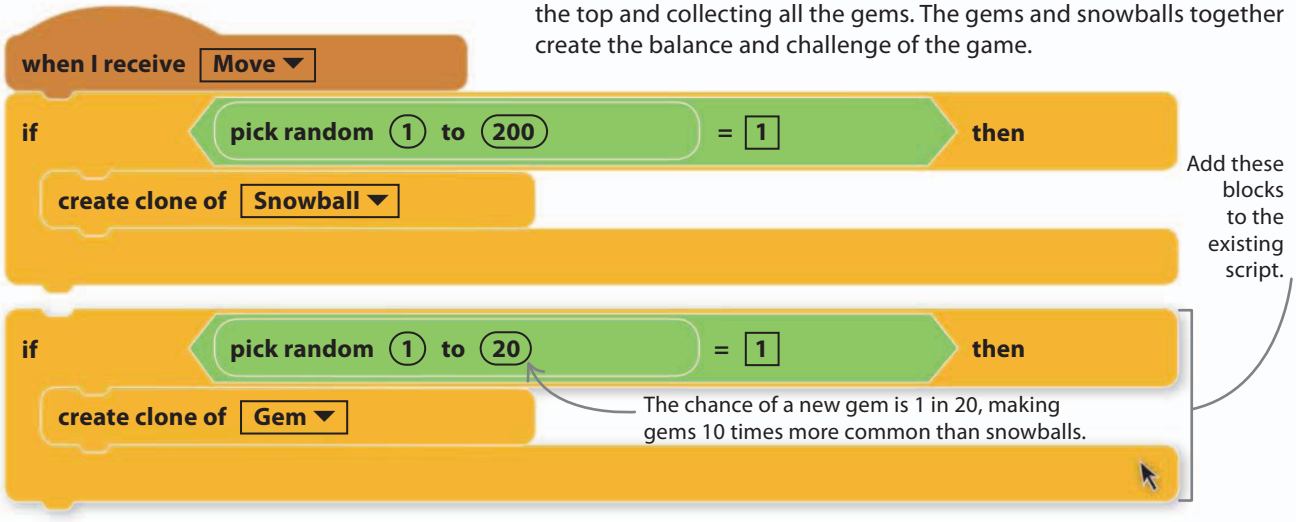
29 Create two variables—"RedCarGems" and "BlueCarGems" (both for all sprites)—to tally how many gems each car collects. Now add these scripts to the Gem sprite; they're similar to the scripts for the snowballs.



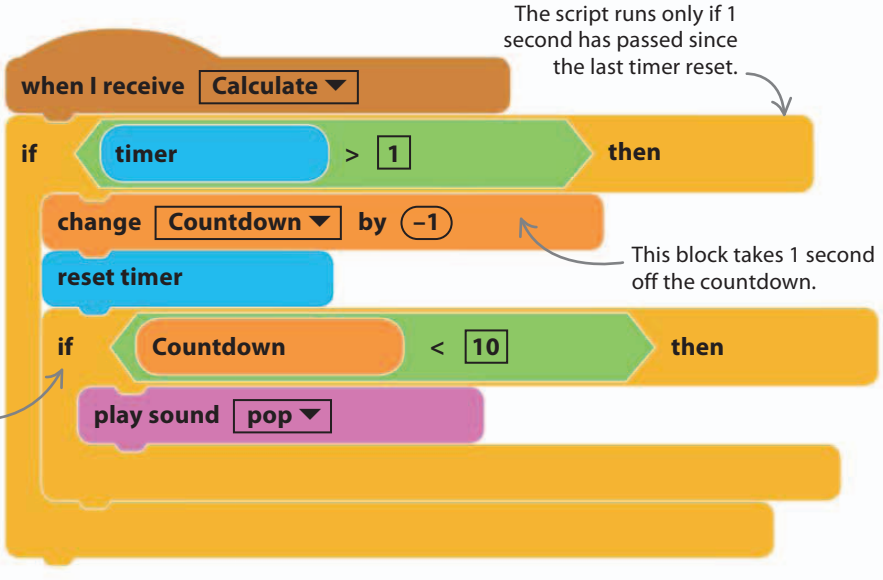
30 Add the following script to move the gems along with the road and to update the total number of gems collected by each car. Load the "fairydust" sound to the Gem sprite so that it plays each time a gem is collected.



31 In the Game Loop sprite, add a second "if then" block to the "when I receive Move" script to create the gem clones. Run the game and try collecting gems. The snowballs will prevent players from rushing to the top and collecting all the gems. The gems and snowballs together create the balance and challenge of the game.



32 You'll notice that the countdown isn't working and the game never ends. To fix the problem, add the script on the right to the Game Loop sprite and try the game again. When the countdown reaches zero, the game should stop.

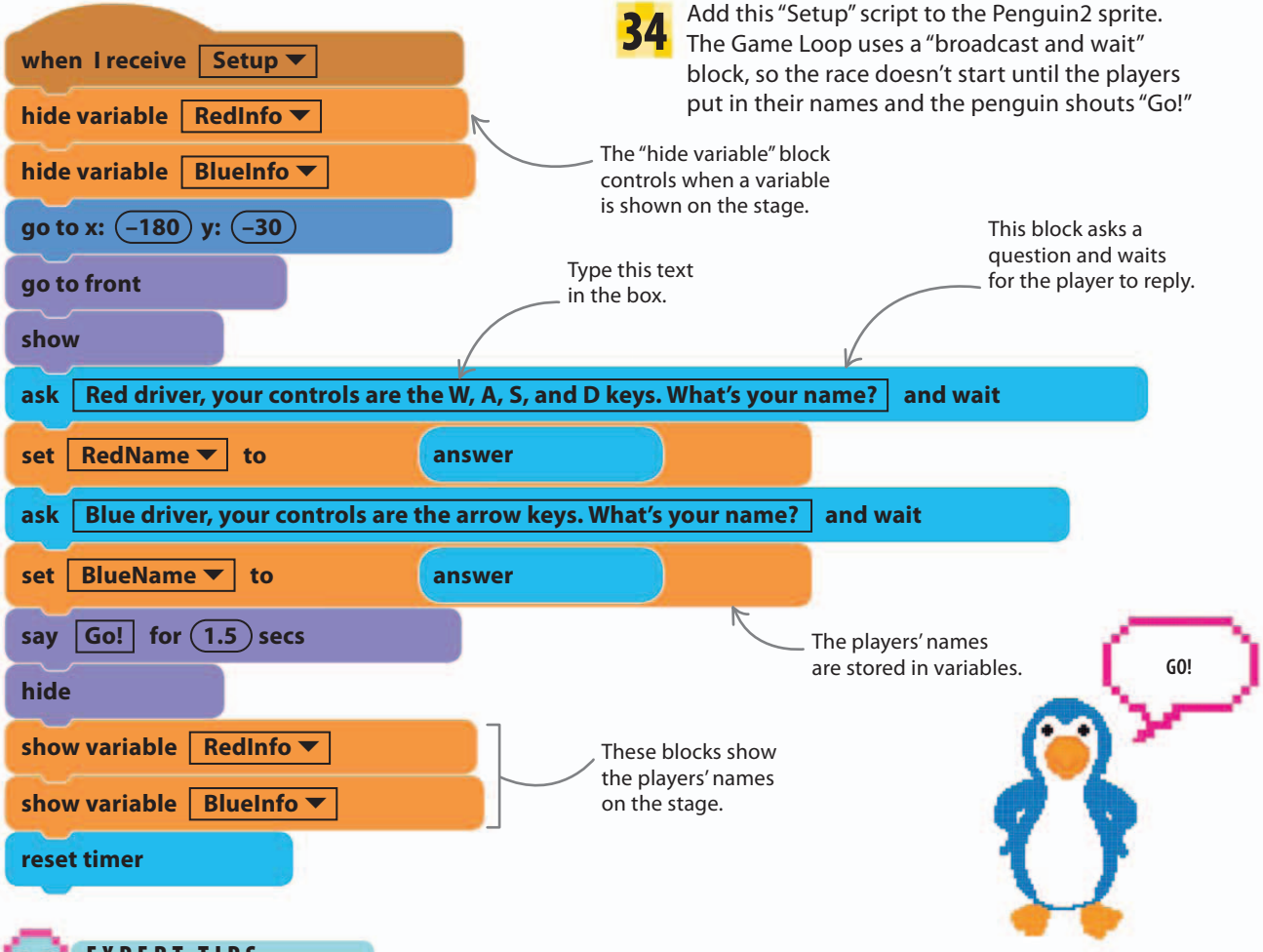


Penguin in charge

A proper start and finish can make a game look more professional. Add a penguin race official to ask the players' names, start the race, and announce the winners.

33 First, create four variables for all sprites: "RedName" and "BlueName" to store each driver's name; and "RedInfo" and "BlueInfo" to show each driver's score during the race. Then add the Penguin2 sprite to talk to the players, and load the "gong" sound from the library to Penguin2.

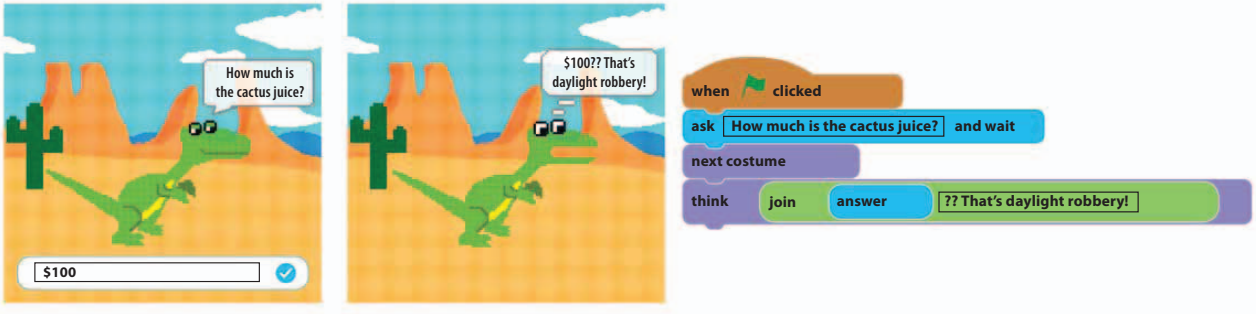
34 Add this "Setup" script to the Penguin2 sprite. The Game Loop uses a "broadcast and wait" block, so the race doesn't start until the players put in their names and the penguin shouts "Go!"



EXPERT TIPS

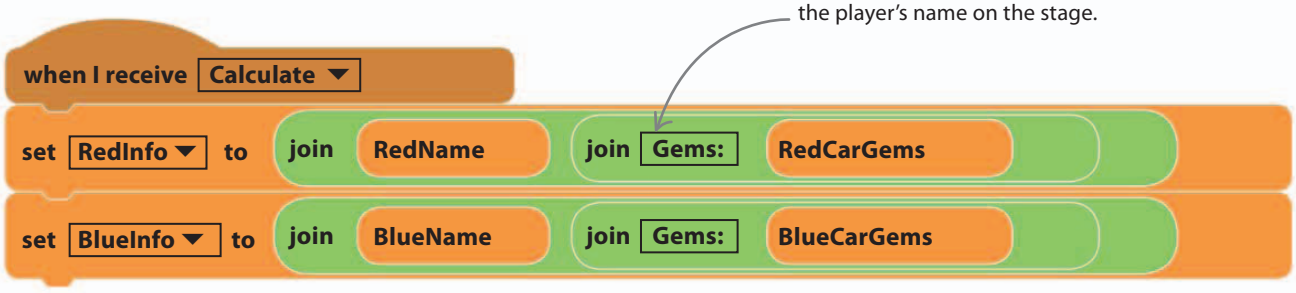
The ask and answer blocks

A sprite can put a question to the person at the computer by using the "ask" block. Anything typed as the reply is stored in the "answer" block, which can then be used inside other blocks just like a variable can.



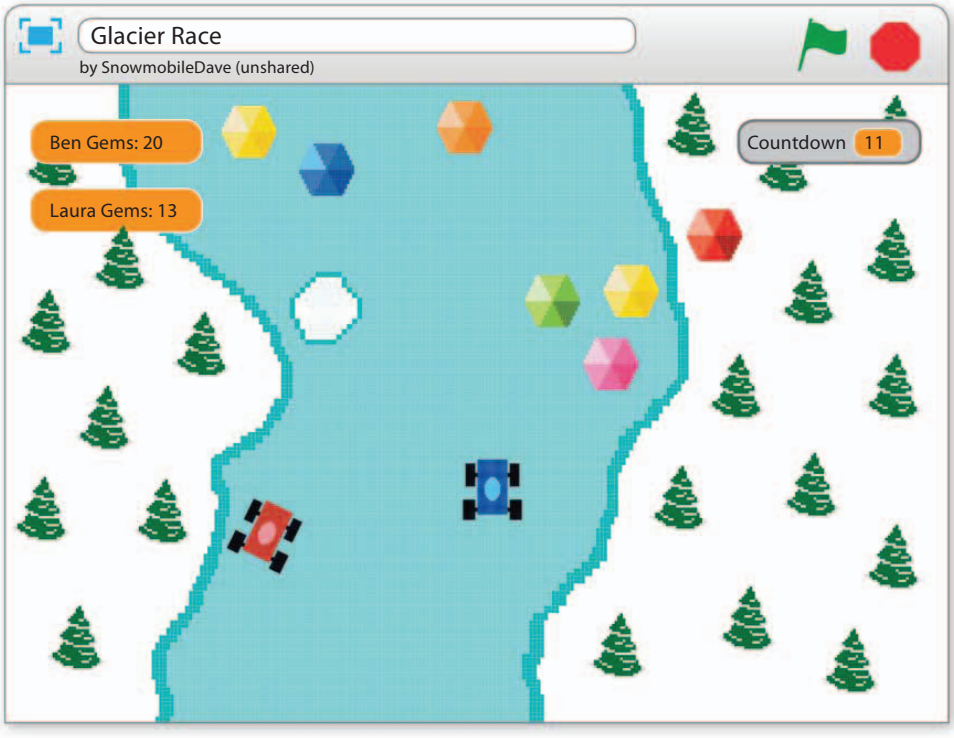
35 Add this script to the Penguin sprite to set the "RedInfo" and "BlueInfo" variables, which are displayed on the screen to show the scores.

Type a space before "Gems:" so that it doesn't form a single word with the player's name on the stage.



36 Run the game. Hide all variables except "Countdown", "RedInfo", and "BlueInfo" by unchecking their boxes in the Data section. Then right-click the RedInfo and BlueInfo signs on the stage and choose "large readout". To make everything look tidy, drag the signs to the top left and move the countdown to the top right.

Check boxes to show the variable on the stage.



LINGO

String

Programmers call an item of data that contains words and letters a "string". It can include any character on the keyboard and can be of any length.

37 To make the penguin announce the winner, add the next script. This script has one "if then else" block inside another. Think about the three possible results—red wins, blue wins, and a tie—and it should all make perfect sense.


```
when I receive GameOver
show
play sound gong
go to x: 0 y: 0
go to front
if RedCarGems > BlueCarGems then
    say join RedName wins!
else
    if RedCarGems < BlueCarGems then
        say join BlueName wins!
    else
        say It's a draw! Try again.
```

Type a space before the word "wins!"

If the red car collects more gems, it is declared the winner.

One "if" block inside another is called a "nested if".

If the blue car collects more gems, it is declared the winner.

Since the only possibility left is a tie, you don't need to add an "equals" block.

38 Finally, add some rhythmic dance music to make the game feel faster. Load "dance around" to the Game Loop sprite and then add this script. It's a loop, and extra loops can slow everything down, but since it only runs once every few seconds it won't affect the game play.

```
when clicked
forever
    play sound dance around until done
```

Load "dance around" from the sound library.

Hacks and tweaks

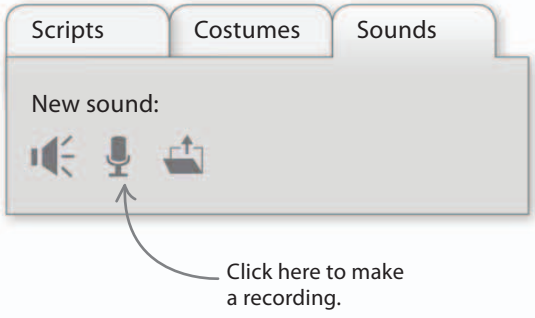
Now over to you! Personalize this race with your own features and adjustments. Make it as fast, slow, hard, fast, serious, or silly as you like.

△ **Instructions**

Remember to add instructions to the project page in Scratch. Make it clear that it's a competition to get the most gems and not a race to the finish line. Give players a helpful hint by telling them they can push the other player off the road.

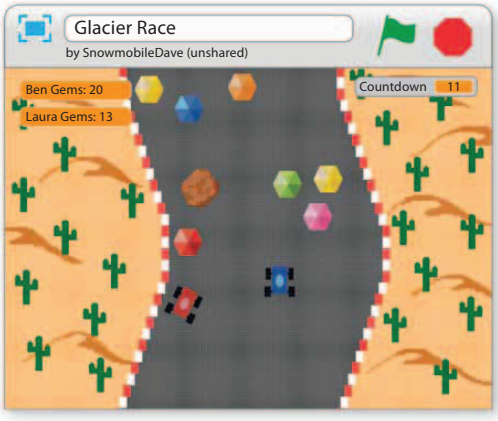
▽ **Record your own sounds**

You can use your own voice to make announcements in the game. To record your voice, you need a computer with a microphone. Select the Penguin sprite and click on the Sounds tab. Then click the microphone icon to make a recording. Replace the Penguin's "say" block with a "play sound" block and choose your recording.



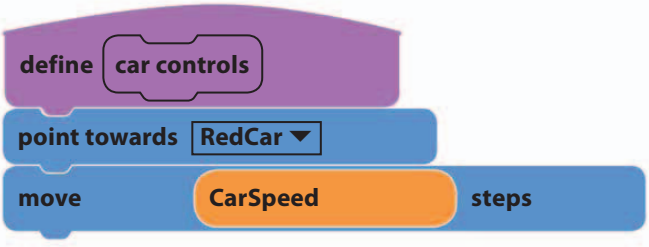
▷ **Fine-tuning**

To change how hard or easy the game is, adjust the "CarSpeed", "RoadSpeed", and "Countdown" variables that are set at the start. You can also adjust how long the cars spin after a crash, how big the bounce is when they collide, and how often snowballs and gems appear. Try to get just the right balance to make the game challenging but not too hard.



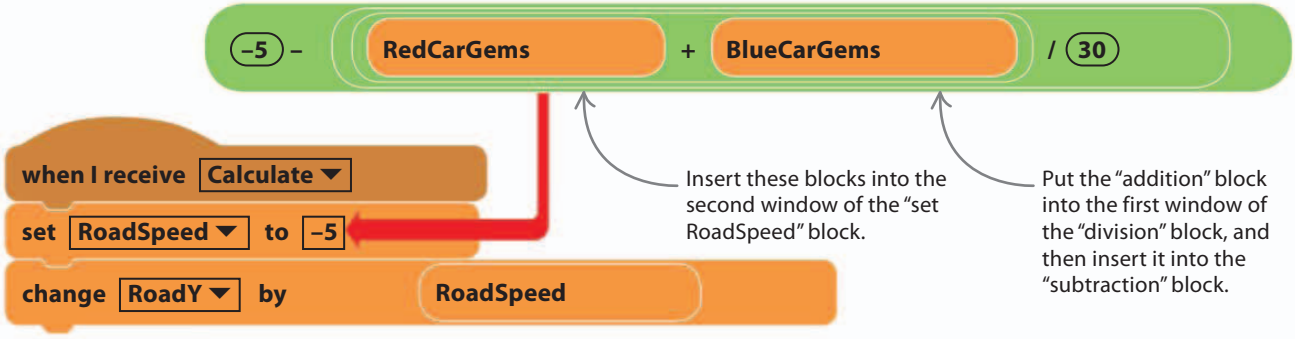
△ **Change the scenery**

It's easy to change the setting of Glacier Race by repainting the scenery. You can make the players race through a desert canyon or a dirt track in a forest. Remember to change the snowballs to match your theme.



△ **One-player game**

Experiment with a one-player version of the game where you play against a computer-controlled blue car. First save a copy of the project so you don't spoil the two-player version. Change the car controls for the blue car, as shown here, and then try the game. The blue car will chase the red car and crash into it.

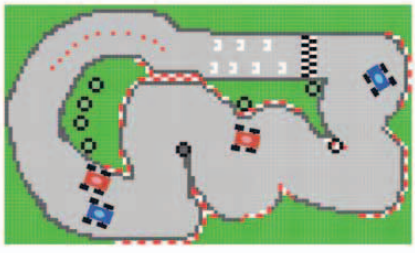


△ **Need for speed**
For extra thrills, you can make the game speed up as players collect more gems. To do this, change the "set RoadSpeed" block in the Game Loop sprite so that the variable changes with each gem collected.

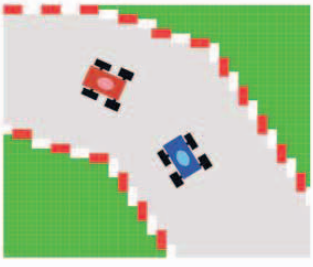
GAME DESIGN

Camera angles

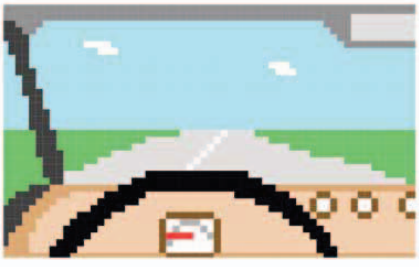
Game designers often talk about the "camera" in a computer game. This refers to how the picture on the screen follows the action in the game. There is no real camera, but if you imagine a camera capturing the action, you can think about different ways of showing what's going on. Here are some common camera views in computer games.



◁ **Fixed**
The camera watches all the action from one spot, without moving. Most of the games in this book use this simple camera, either with a side or bird's-eye view of the action.



△ **Tracking**
This camera follows the player around the game. In Glacier Race, the camera follows the cars, keeping them in view as the road moves by.



△ **First person**
This camera shows the view the player would see through their own eyes. First-person games make the player feel immersed in the action, rather than watching from afar.

△ **Third person**
This type of camera is positioned just behind the player's sprite. The player feels involved in the action, but can clearly see what the sprite is doing.

10

Tropical Tunes

How to build Tropical Tunes

Computer games aren't just about quick reflexes—they can also challenge your thinking powers. Here's a brain game to test how good your memory is.

AIM OF THE GAME

In Tropical Tunes, you have to listen to the drums play and then repeat the ever-growing tune. Make a mistake and the game's over. The longer you can match the tune, the higher your score.

◁ **Listen**
The drums play a tune, starting with a single note and then adding one new note each time.

◁ **Drums**
Click the drums in order to repeat the tune the game plays to you.

◁ **Game over**
Make a mistake and the game ends. As the tune gets longer, the game gets harder.

GAME CONTROLS

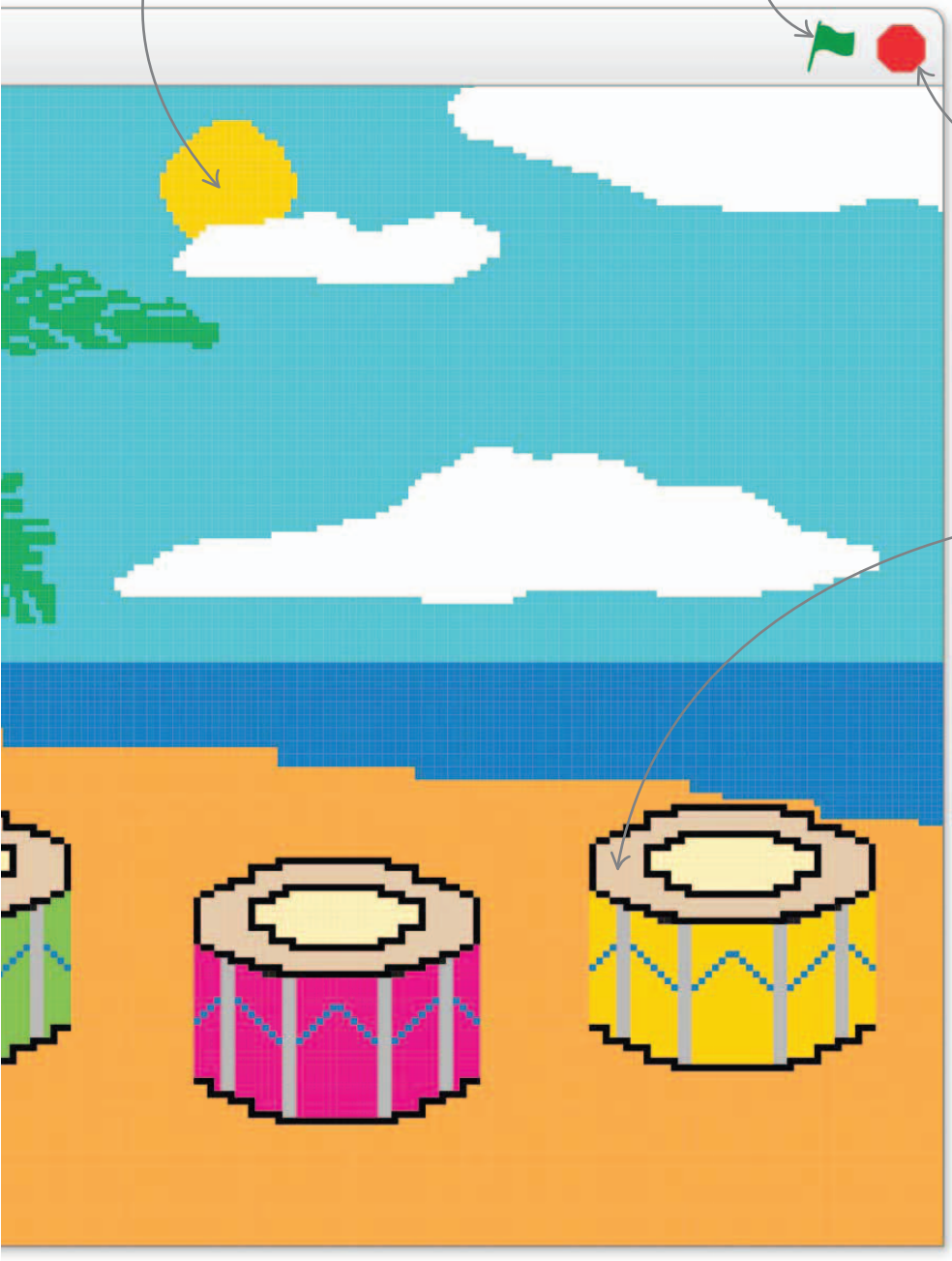
Use a computer mouse or touchpad to play this game.

A tropical backdrop sets the scene, but the background in this game isn't important.

Click the green flag to start a new game.

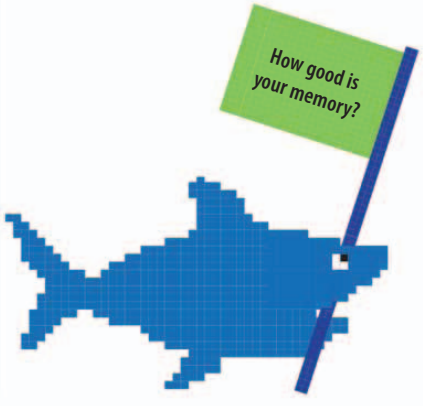
Click the stop sign to end the game.

The drums jump out when they play a note.



◁ **Harder and harder**

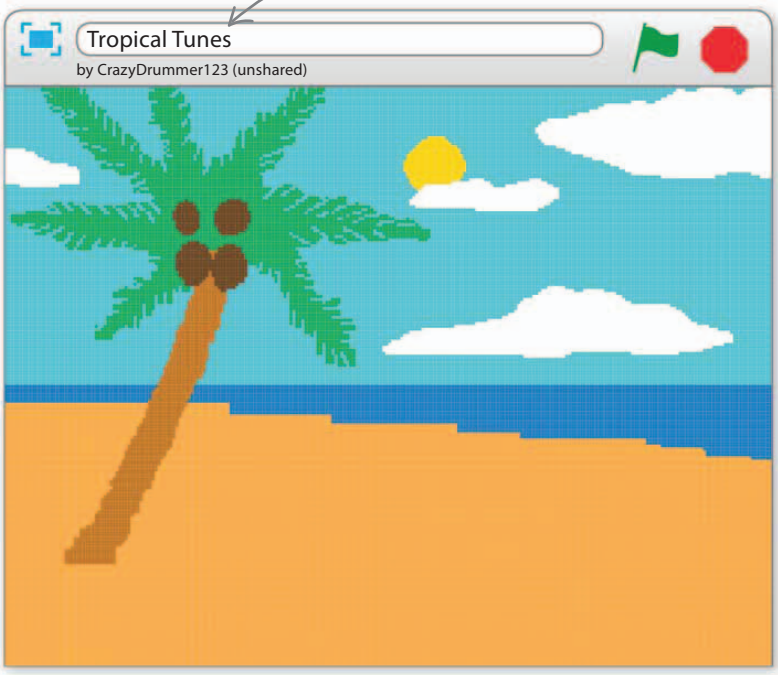
This game gets harder the longer you play. To help you remember the sequence, each drum plays a different note and has a different color, but eventually you won't be able to remember the whole pattern!

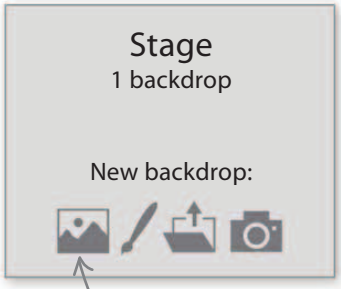


Make a drum

This game is quite complicated, so you'll need to work through the instructions carefully. To get started, follow the directions to make one drum with all the scripts it needs. Once that's done you can copy it to make all four drums. Later, you'll create a game loop called the "master controller" to play the drums.

1 Create a new Scratch project and add or create any backdrop you want. A tropical theme works well with this game.

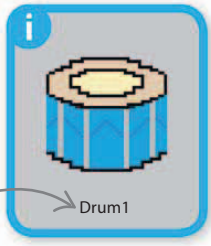




Click this icon to open the backdrop library.

2 The game needs four drums, but you can make just one to start with. Delete the cat sprite and add the "Drum1" sprite from the sprite library. Drag it to the lower left of the stage.

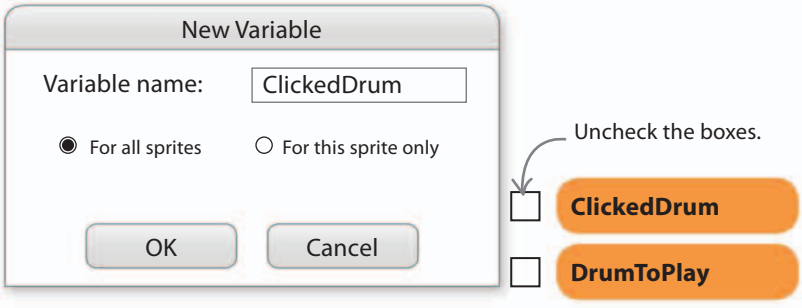
The name "Drum1" will be given to the sprite automatically.



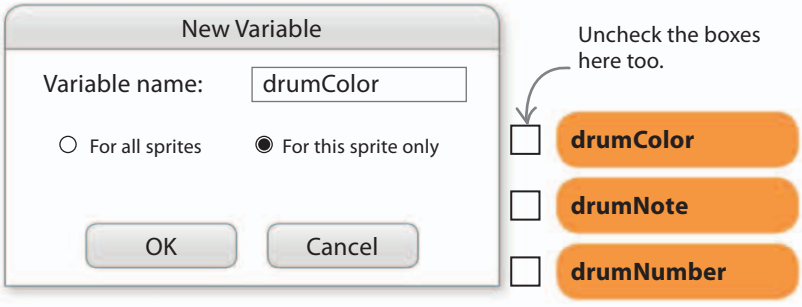
Two types of variable

You may have noticed the option to choose "For all sprites" or "For this sprite only" when you create a variable. So far you've mostly used "For all sprites", but you'll need to use both options in this game.

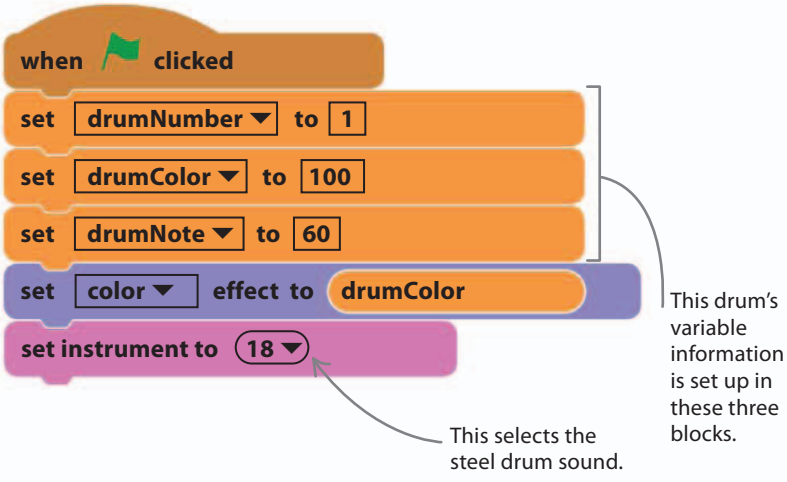
3 Before you can start making the scripts that bring the drum to life, you need to create some variables. Click on the Data section and make two variables for all sprites called "DrumToPlay" and "ClickedDrum". Uncheck their boxes. Every sprite in the game can use these variables.



4 Now add three variables "For this sprite only". Call them "drumColor", "drumNote", and "drumNumber". These variables will store information about only Drum1: its number, its color, and which note it plays. Using "For this sprite only" enables you to copy this sprite to make more drums later, while allowing each drum to have different values for these variables.



5 Build the script below for Drum1. It sets up the drum's number, color, the note it plays, and the type of sound it makes (like a steel drum). Run the project to set the variables and watch the drum change color.



LINGO

Variables

Programmers have special terms for variables that apply to all sprites or only one sprite.

▷ Those that apply to only one sprite are called **local variables**.

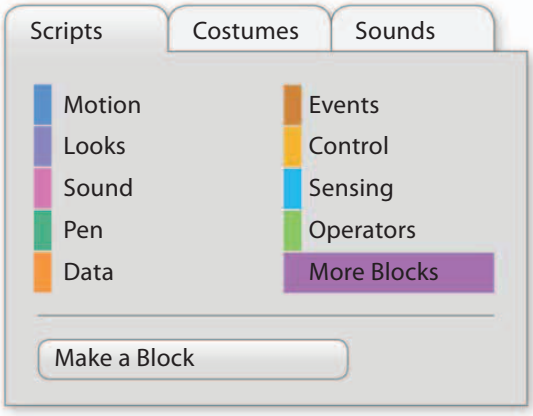
▷ Those that apply to all sprites are called **global variables**.

To help you tell which is which, all the global variable names in this book start with a capital letter and local variable names don't.

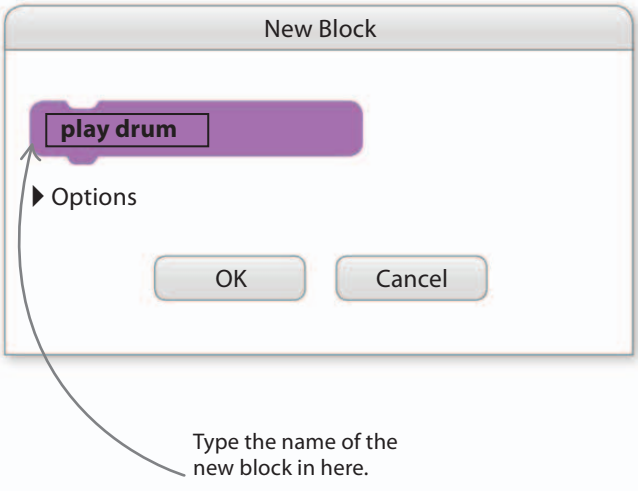
Making your own block

In Dog's Dinner and Glacier Racer, you found out how to create your own customized Scratch blocks. You'll need to create a few more in this game.

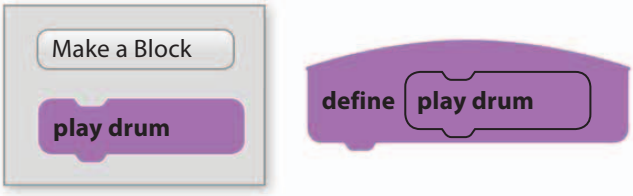
6 Go to the blocks palette and select "More Blocks". The option "Make a Block" will be visible.



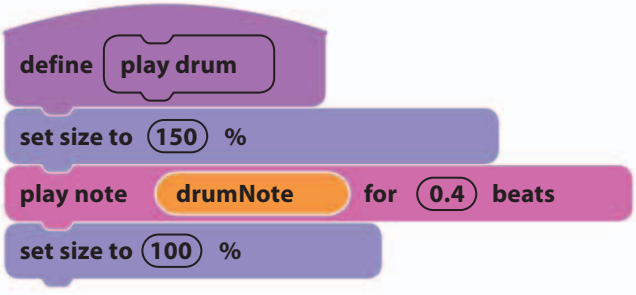
7 Select "Make a Block" and a box will pop up. Type in the name of your new block: "play drum". Then click "OK".



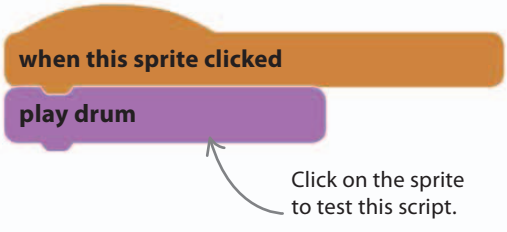
8 Next, the new block appears in the blocks palette and a special purple header block, "define play drum", appears in the scripts area.



9 Build this script below the "define play drum" block. Then, anywhere you use the "play drum" block, Scratch will run the script. The script will make the drum grow in size, play a note, and then shrink back to normal. You can test the new "play drum" block by clicking on it.



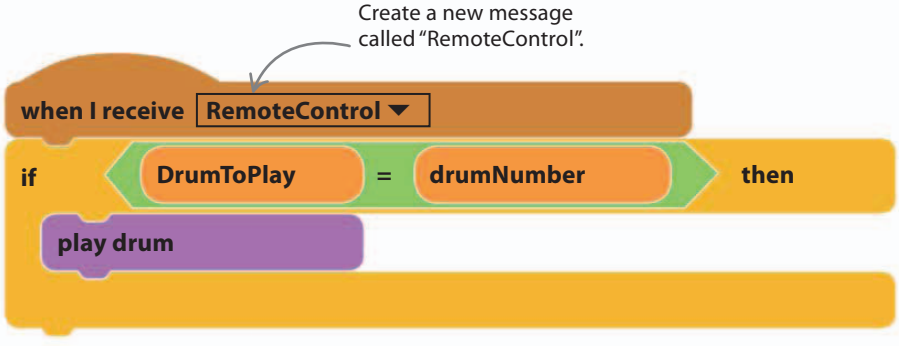
10 Now add this short script to Drum1. Click the drum on the stage to test it. Before testing, you'll need to click the green flag to set the value of drumNote.



Remote control drums

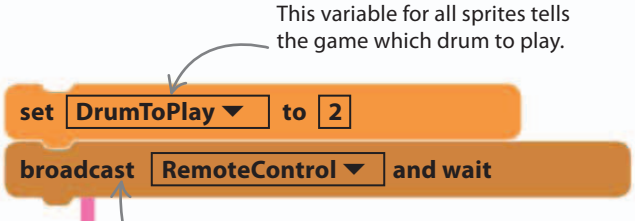
Tropical Tunes makes the drums play a sequence that the player has to copy. The game controls the drums by using a master controller to send messages to them and then wait for a reply. Before you set up the master controller, give Drum1 the scripts it needs to receive and broadcast messages.

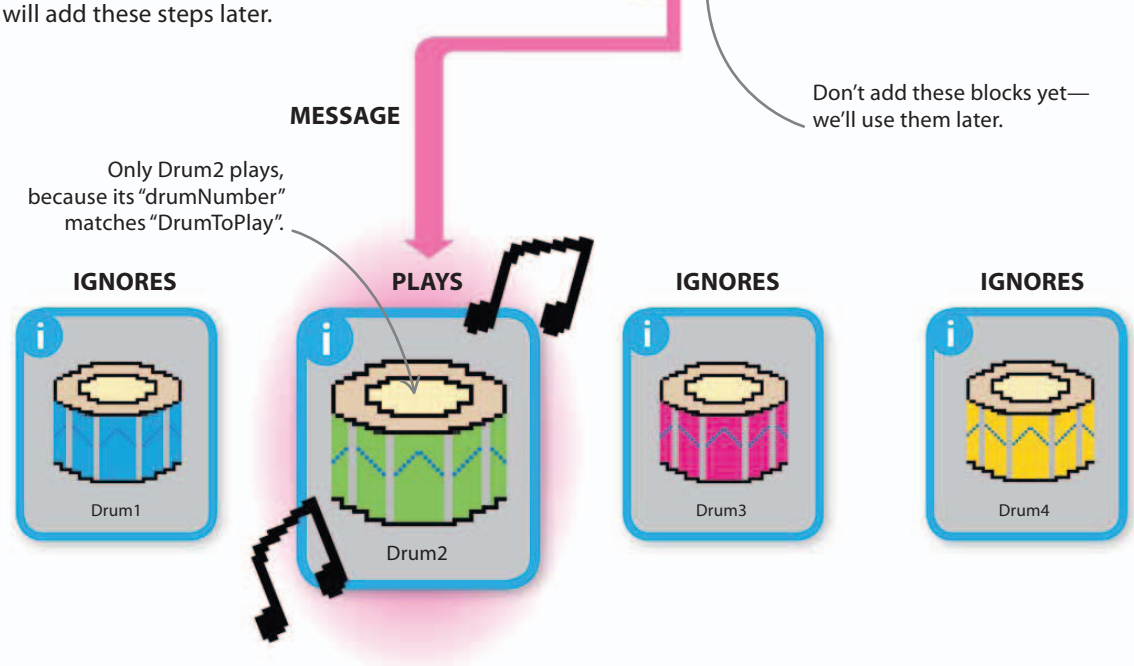
11 Build this script, which will be triggered by a message called "RemoteControl". Create the message by selecting the drop-down menu on the "when I receive" block. Choose "new message" and type in "RemoteControl".



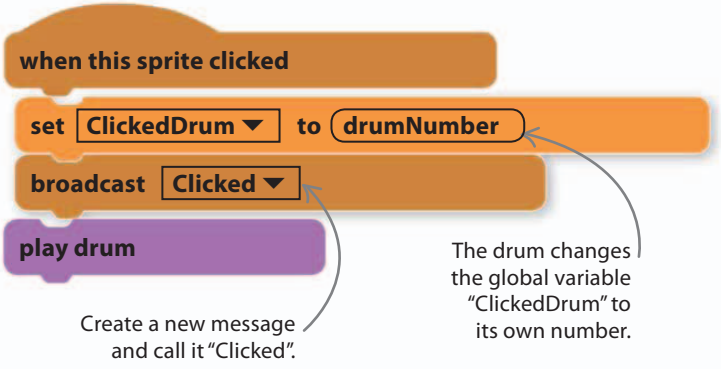
▽How it works

Eventually there will be four drums numbered 1 to 4 (the local variable drumNumber). Before the master controller broadcasts "RemoteControl" it will set the *global* variable "DrumToPlay" to the number of the drum it wants to sound, and only the matching drum will play. We will add these steps later.





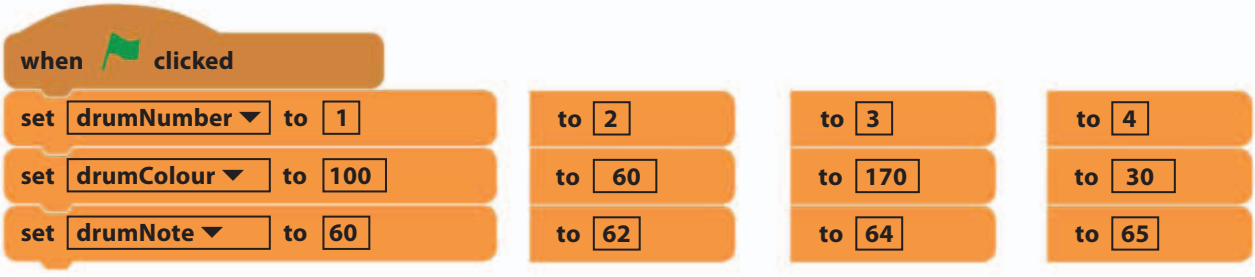
12 When the player clicks a drum, the master controller will need to check it's the right one. To make this work, you need to make the clicked drum do two things. First, it will change the global variable "ClickedDrum" to its own number. Then it will broadcast a message to make the master controller run its check. Change Drum1's "when this sprite clicked" script to look like this.



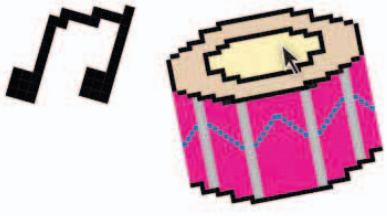
Four drums

You now have one drum complete with its scripts. You can copy it three times to create the four drums you need for this game.

13 Duplicate the drum three times, then change the values of the three local variables as shown below to give each drum a different number, color, and note. Arrange the drums on the stage, ordered from one to four.



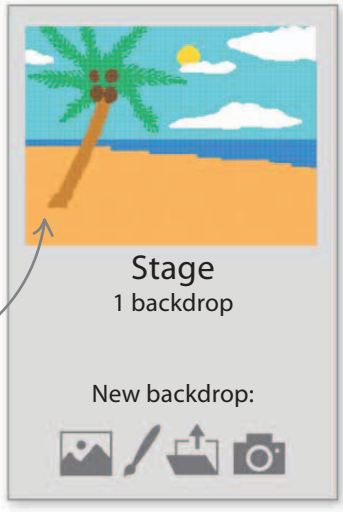
14 Now run the project. Each drum should become a different colour. Click on them in turn to hear them play. If they move instead of playing, click on the blue full-screen symbol in the top left of the stage. Nothing else will work yet, but it's good to test that your drums all play correctly.



The master controller

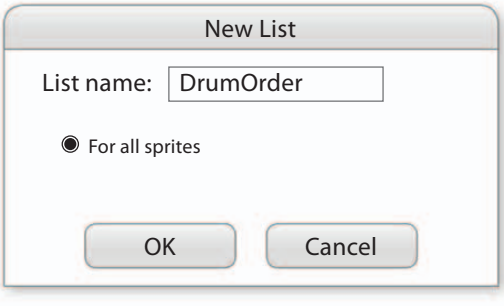
Now you need to create the game's main brain: the master controller. The master controller broadcasts the "RemoteControl" message that plays the drums, but it does several other jobs too. It generates the drumbeat sequence the player has to follow; it checks that the player has clicked the right drum; and it keeps track of the score. It will need several scripts to do all this.

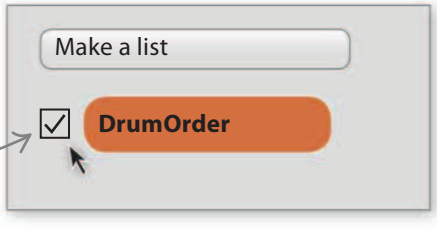
15 The stage is a good place to put the master controller scripts as they don't belong to any one sprite. Click on the stage info area at the bottom left of the screen to choose the stage.



Click here to add scripts to the stage.

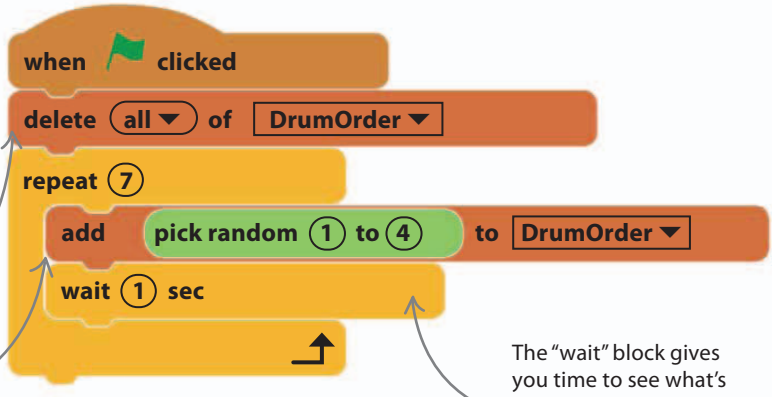
16 The master controller will keep track of the ever-growing sequence of drumbeats by storing them in a numbered list. To create the list, open the Data blocks section and click the "Make a List" button. Name it "DrumOrder"—it's going to store the order in which the drums will play. Check the box so you can see it on the stage.



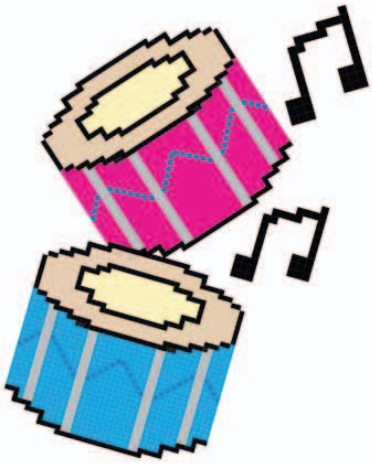


Check here to show the list on the stage.

17 With the stage selected, build this test script to generate a random sequence of seven drum numbers in the list. This script isn't part of the final game (for that, the script will need to add notes one by one). However, building it will show you how lists work and will let you try out the drums.



18 Run the script and watch the "DrumOrder" list on the stage slowly fill up. It will look like this, but your numbers won't be the same. The drums don't play yet because there are no blocks to tell them to.

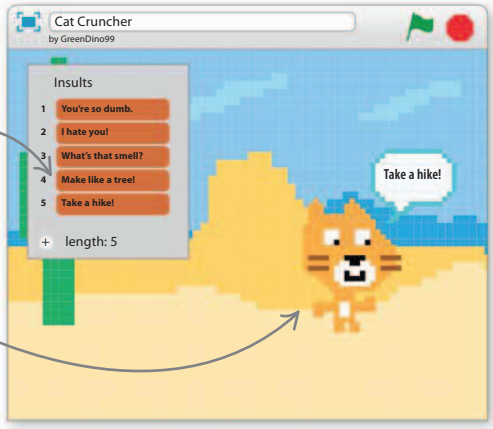


EXPERT TIPS

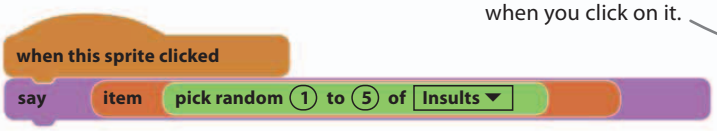
Lists

Making a list is a great way to store information, and lots of programming languages use them. They are handy for all sorts of things, from creating leaderboards and doing complex calculations to giving sprites artificial intelligence. In Tropical Tunes, we use a list to store numbers, but you can store words in lists too.

Lists are usually hidden, but you can display them on the stage just like variables.

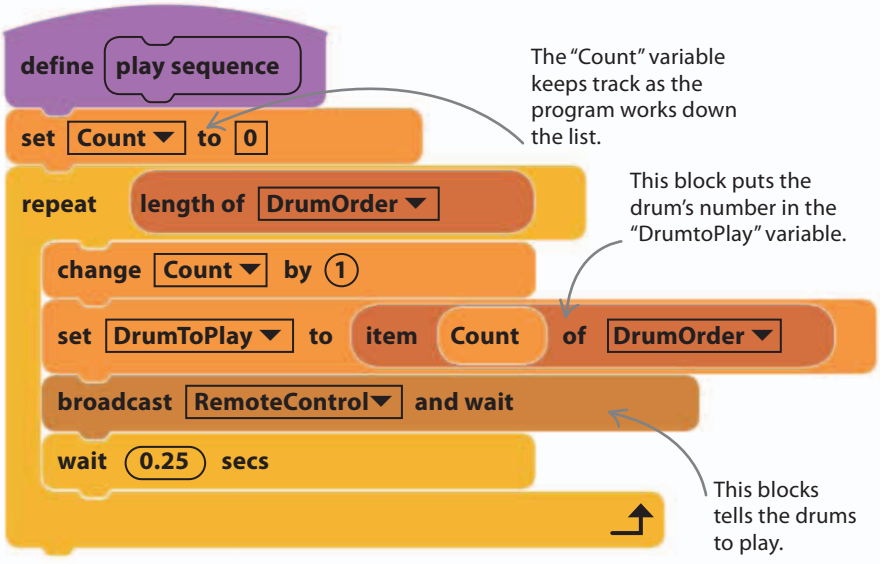


You can use a list to make a sprite say something random when you click on it.

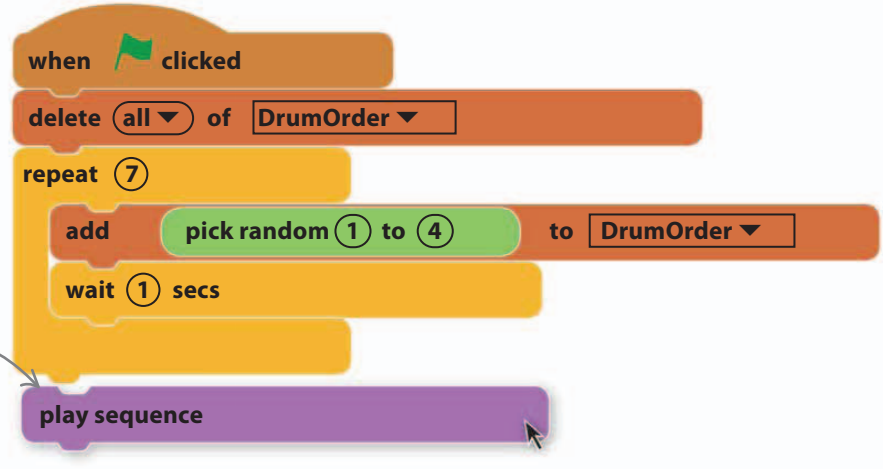


Commanding the drums

19 Now create another new block called "play sequence" and build the script shown here. It will play the notes in the list in order by travelling once though the blocks in the loop for each item in the "DrumOrder" list, setting "DrumToPlay" from the list, and then sending out the "RemoteControl" message. You will need to create a new variable for all sprites called "Count".



20 Add the new "play sequence" block to the test script.



EXPERT TIPS

Broadcast blocks

There are two types of broadcast Scratch blocks. They are useful in different ways.

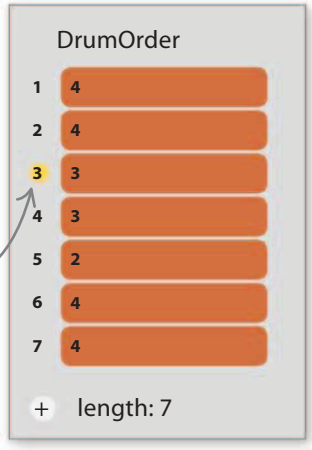
△ **Broadcast**

This sends the message but then continues straight to the next block without waiting. This is useful for triggering an event without stopping what's going on, such as launching an arrow without pausing the loop that moves the player's sprite.

△ **Broadcast and wait**

This sends the message but then waits until all receiving scripts have finished before running the next block. This is useful when you don't want the script to continue until something's finished, such as the drum playing in this game.

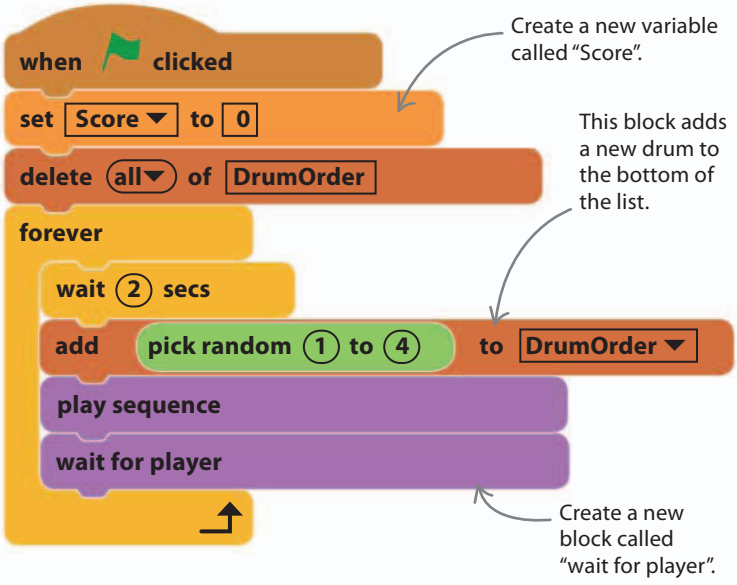
21 Now run the script. Watch the numbers alongside the items in "DrumOrder" light up as they are read by the script, then hear and see the correct drum play each time. You can check the "DrumToPlay" variable's check box to show the number used with the "Remote Control" message for each note.



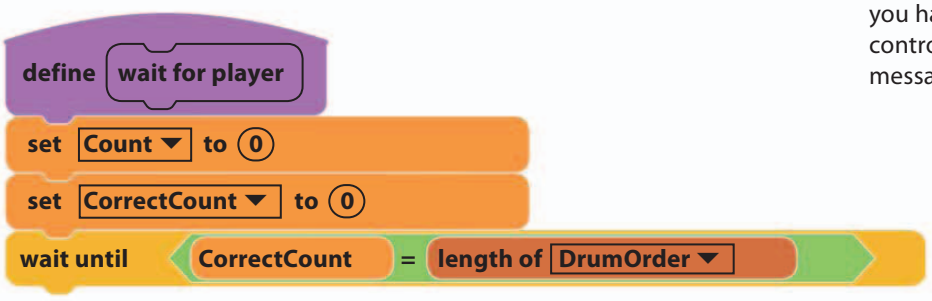
Adding notes to the tune

So far you've just been testing the drums. It's now time to get them playing the sequences needed in the game, starting with one note and adding another note each time the player repeats the tune correctly.

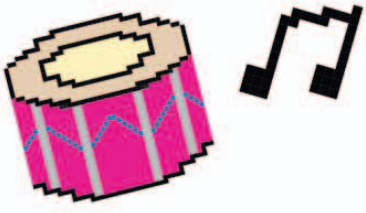
22 The test script isn't needed any more so replace it with this one. You'll need to create another new block called "wait for player"—its script is shown in the next step. You'll also need to create a new variable for all sprites, called "Score", and check it so it appears on the stage.



23 Add a new variable called "CorrectCount" to count how many drums the player gets right. Then create this script, which holds up the loop while it waits for the player to get the whole drum sequence right.



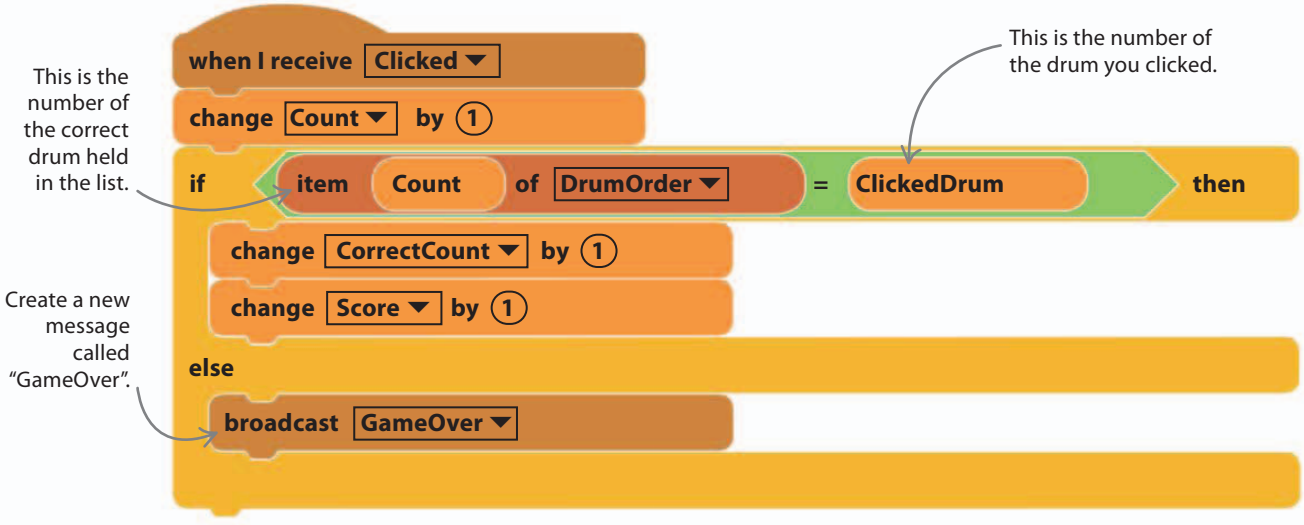
24 If you run the project now, the drums will play one note and then wait. You can click as many drums as you like but nothing will happen because you haven't programmed the master controller to respond to the "Clicked" message yet.



Checking the player's tune

Now you need to add a script to respond to the player's clicks on the drums. Every click creates a "Clicked" message that can trigger a script to check which drum was clicked and count the number of correct clicks. If the player clicks the wrong drum, the script will broadcast a "GameOver" message.

25 Add the next script to the stage to increase "CorrectCount" by one for each correct click. When the drums are clicked, they play and send the "Clicked" message, having put their number in "ClickedDrum". This script will be triggered by that "Clicked" message. If the numbers don't match, the game ends.



26 Add a game-over script to the stage. You'll need to load the "bell toll" sound to the stage from the Scratch sound library.

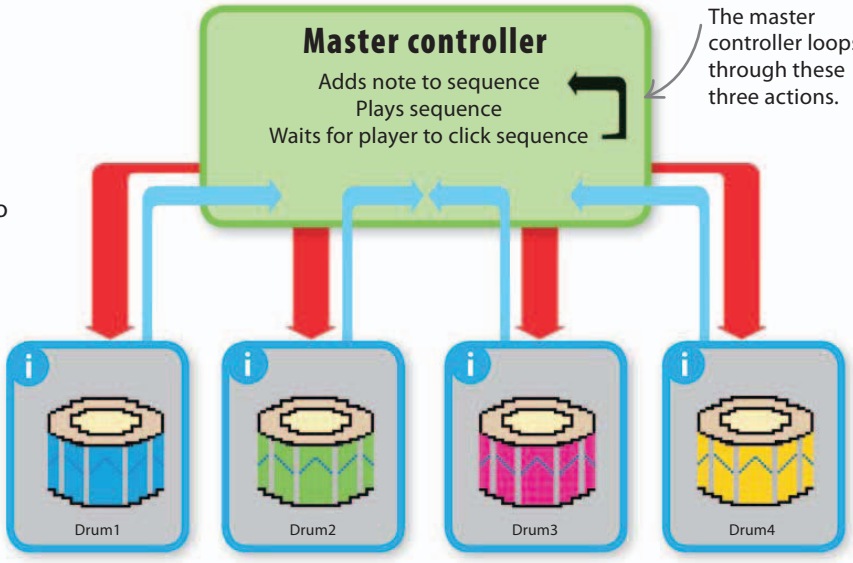
27 The game is complete. Now try playing it, but remember to uncheck "DrumOrder" in the Data section of the blocks palette or the player can just read the correct drum order off the list.

▷ **How it works**

This game relies on two messages: "RemoteControl", which tells a drum to play, and "Clicked", which tells the master controller that a drum has been clicked by the player. The master controller has a loop that uses these two messages in turn—to play the tune and then check the player's reaction.

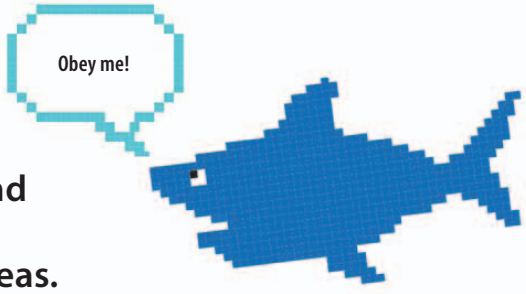
"RemoteControl" message makes the drums play.

"Clicked" message tells the master controller when a drum is clicked.



Hacks and tweaks

Once everything is working smoothly, you can play around with the code and tweak the game to try and make it more exciting or harder. Here are some ideas.



△ **Talking shark**

Try adding a shark sprite that swims up and gives instructions—make him talk using the "say" block.

▽ **Another drum**

Add a fifth drum. You'll need to change its drum number, note, and color values, and check anywhere in the code that thinks there are only four drums—such as the random block in the master controller.

14

△ **Round counter**

Create a new global variable "Round" and show it on the stage. Set it to zero at the start of a game and increase it by one every time the player completes a sequence correctly (at the end of the master controller loop).

◁ **Game over**

Add a "Game Over" sign or make the shark swim back onto the stage to say it.

EXPERT TIPS

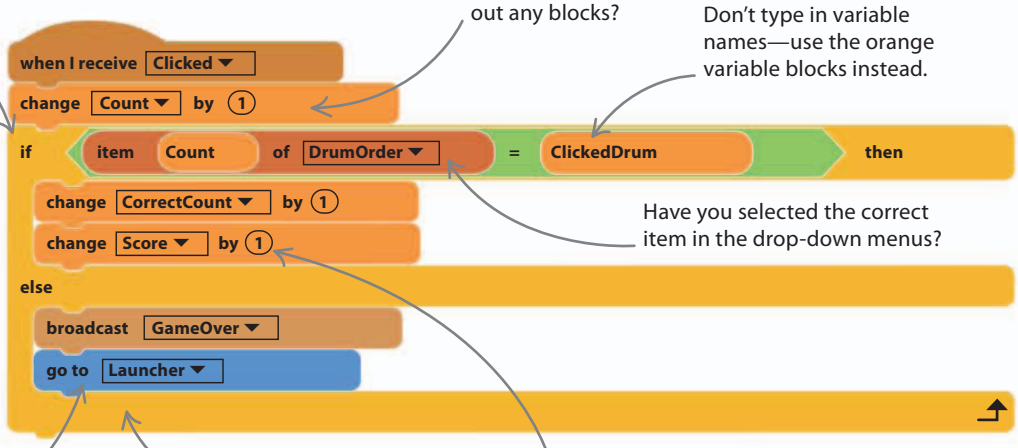
Debugging

Bugs are errors in programs. Getting rid of them is called debugging. If a program isn't working properly, there are a number of common Scratch problems you can check for, which are shown below. If you're following instructions and something isn't working, it's also worth going back to the beginning and checking all the steps—there could be a small mistake in one of your scripts that is affecting the whole game.

Have you missed out any blocks?

Don't type in variable names—use the orange variable blocks instead.

Are your loops and "if" blocks one inside the other when they shouldn't be? Or are they one after another when they should be inside?



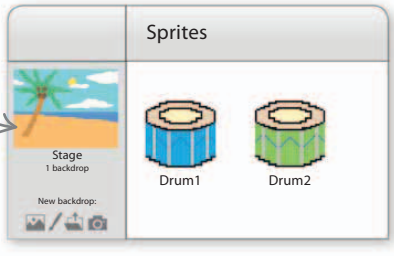
Have you selected the correct item in the drop-down menus?

Have you confused similar blocks like "go to" and "point toward"?

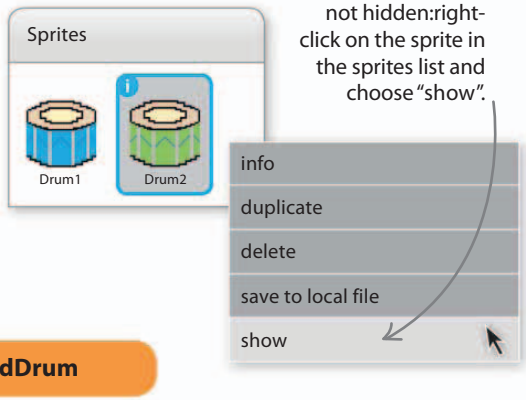
Is a loop that should be around the blocks missing?

Are all the numbers in the windows of the Scratch blocks correct?

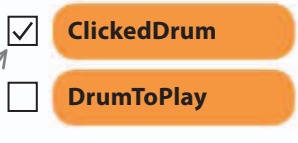
Are the scripts attached to the correct sprite or the stage? It's easy to put a script in the wrong place.



If a sprite disappears from the stage, check that it's not hidden:right-click on the sprite in the sprites list and choose "show".



Try showing key variables on the stage by checking their boxes in the orange Data section. If their values look odd or don't change, they might give you a clue about what's wrong.



11

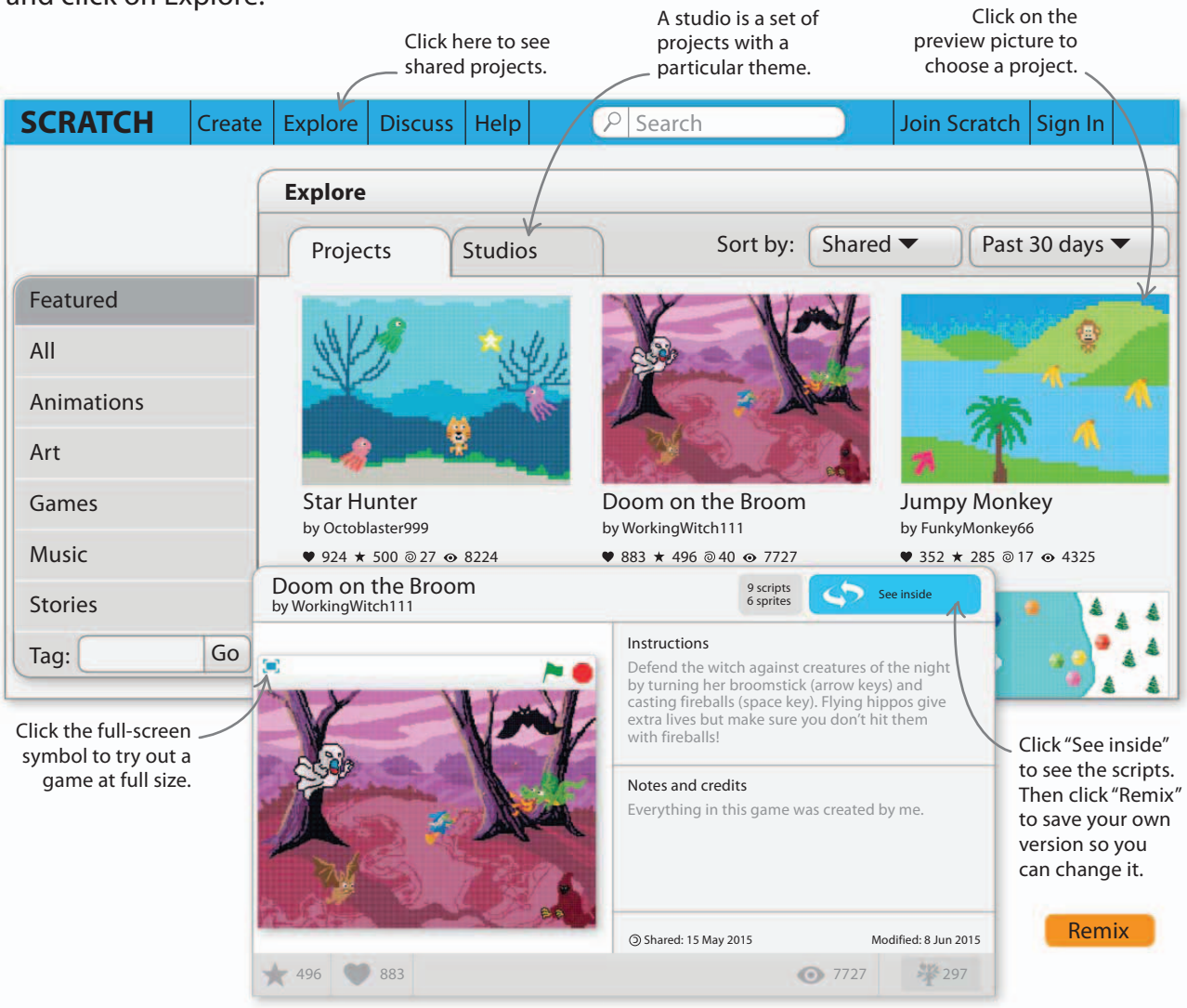
What next?

Remixing and beyond

The Scratch website allows you to see other users' code and reuse it in your own games; this is called remixing. Millions of projects have been shared online and you can dive into every one. It's a great place to share your games and find ideas.

Exploring Scratch

To see games shared by other Scratch users, go to the Scratch website at **www.scratch.mit.edu** and click on Explore.



Creating your own games

Once you've built all the games in this book, you'll probably be bursting with your own game ideas. Here are some tips to help you get started.

1 **Big and small ideas**

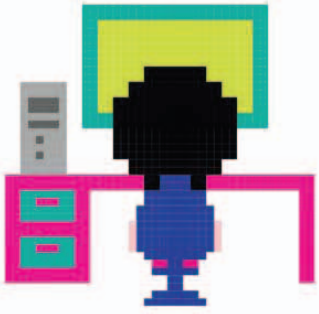
Good ideas can come to you at surprising times, so be ready to jot them down before you forget them. Don't just keep notes about new games—write down ideas about smaller details such as characters, objects, levels, and actions.

2 **Beg, borrow, and steal**

People say the best ideas are stolen. Scratch allows you to steal ideas from everyone else, so go ahead. Look through other people's projects and save any sprites, costumes, backdrops, sounds, or scripts you like in your backpack, so you can reuse them later.

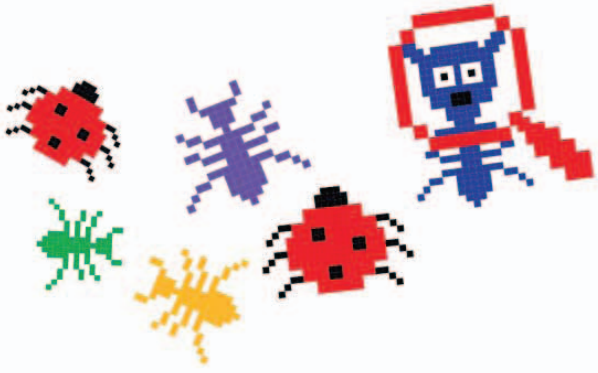
3 **Code your game**

Start with the basics. Begin by coding the main character so it works with your chosen controls (keyboard or mouse). Then build up slowly, adding one sprite at a time and creating the scripts it needs to play its part in the game.



4 **Testing**

Once you're happy with the game, ask someone else to play it. They might find problems that you missed because you know the game too well. Fix any bugs and make sure it all runs smoothly.

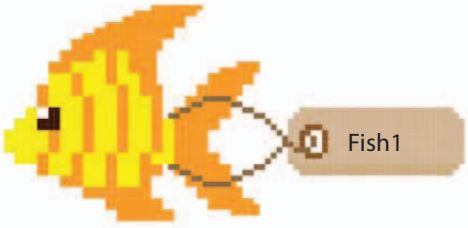


5 **Share it!**

Click the "See project page" button at the top right of the Scratch editor and add a few words to explain how to play the game. Then click on "Share" to allow the whole world to play your masterpiece. Well done, you are now a game maker!

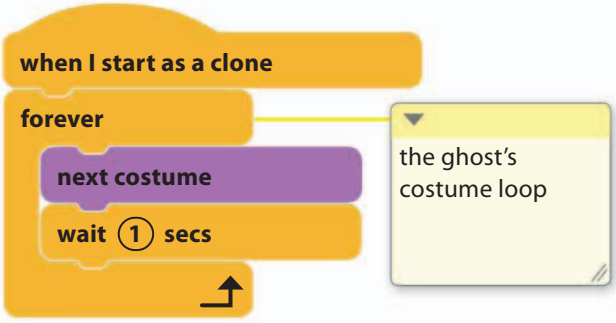
Better Scratch

Good programmers try to write code that's easy to understand and change. There are many ways in which you can improve your projects and expand your knowledge of Scratch. Here are a few of them.



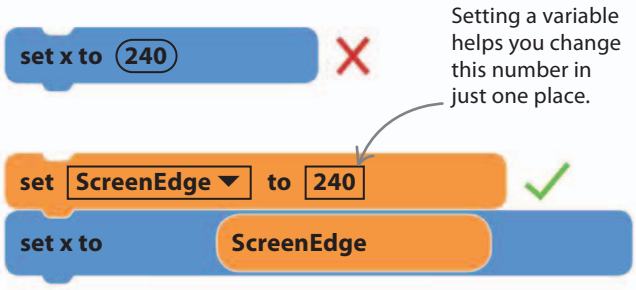
△ **Use clear names**

Scratch lets you choose names for sprites, variables, and messages. Make sure you use meaningful names, such as "Dragon" or "Score", to make your Scratch code readable.



△ **Comments**

You can add comments to any block to explain your code. To do this, right-click (control click on a Mac) on it and select "Add comment". This can remind you when you read code written a while ago.

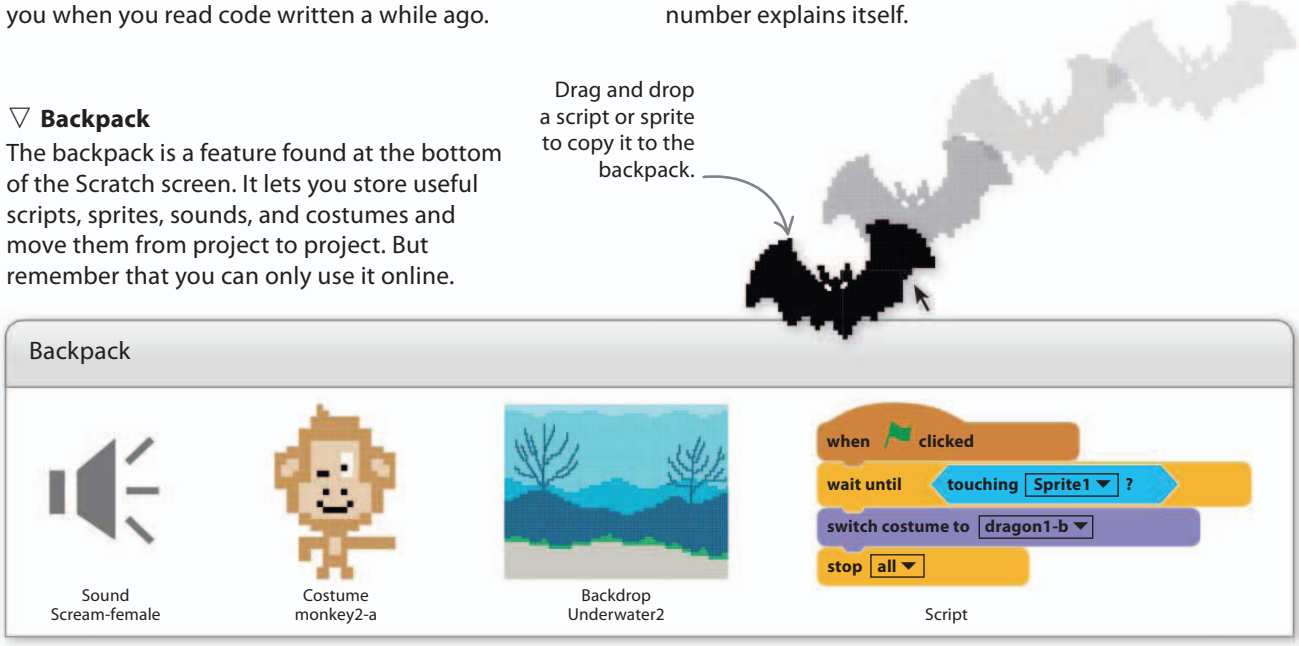


△ **No unexplained numbers**

Avoid writing code that contains unexplained numbers. To make your code easier to read, add a comment or use a variable so the number explains itself.

▽ **Backpack**

The backpack is a feature found at the bottom of the Scratch screen. It lets you store useful scripts, sprites, sounds, and costumes and move them from project to project. But remember that you can only use it online.



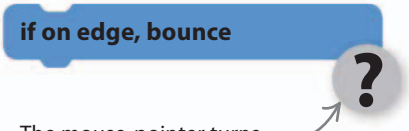
The help tool

Are you still unsure about how to use certain blocks? The help tool in Scratch will let you master the function of each block with ease.

1 To find out more about a particular block, first click the "Block help" symbol in the toolbar at the top of the screen.

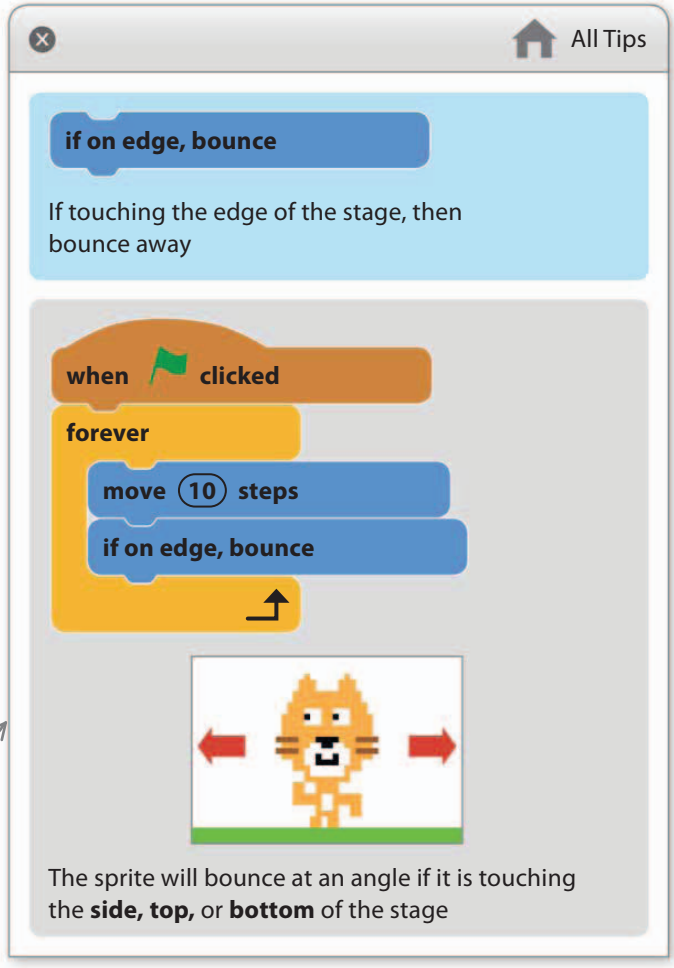
"Block help" symbol

2 After the mouse-pointer turns into a question mark, click on any block in the blocks palette. A help window opens with tips on how to use that block.



The mouse-pointer turns into a question mark.

A help window opens.



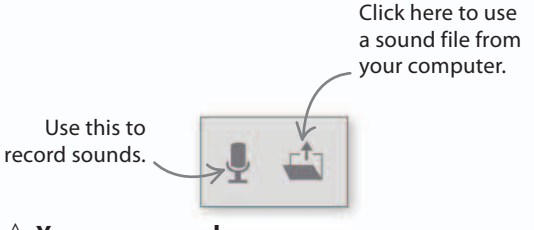
EXPERT TIPS

Making your project different

Scratch projects often look and sound similar if you only use resources from the Scratch library. To make yours different, import your own images and sounds into Scratch.

△ **Your own images**

You can import any image into Scratch, but don't share a project containing photos of people you know. You can also create your own images with a graphics program or the paint editor in Scratch.



△ **Your own sounds**

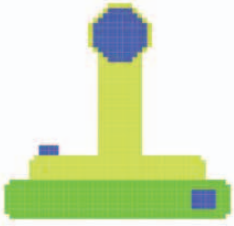
You can record your own music and sound effects through your computer's microphone and edit them in Scratch. You can also find free music and sounds on the web to use in your games.

The next level

Once you've made a few Scratch games of your own, you may want to expand your horizons. There's a whole world of knowledge and experience you can tap into to improve your game design and programming.

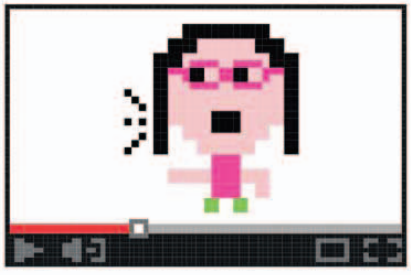
Game design

Begin by improving your knowledge of games and how they're created. The following activities will expand your imagination and stimulate your game-design brain.



◁ **Play games**

Playing games can trigger ideas for new ones. Try out different games and watch other people playing them. Think about the actions (mechanics), rules, and goals that make a good game work. Imagine how you might code these different parts of the game yourself.



△ **Learn from the experts**

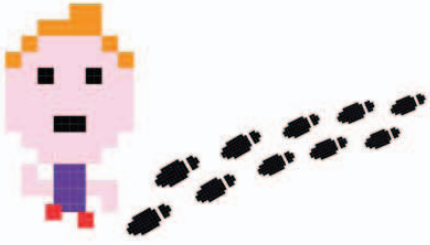
Many game designers love to talk and write about how they design games. You can find their tips on video-sharing websites and in blogs and magazines.

▷ **Find stories**

Ideas for games and the characters in them often come from stories. Next time you watch a good film or read a good book, think how you might turn it into a game.

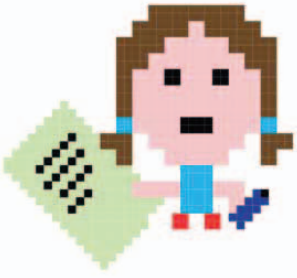
▷ **Explore gaming history**

Find out more about the history of gaming. Visit a video game museum or a vintage arcade. There are lots of free online versions of famous video games, so it's easy to try classic games this way.



△ **Think visually**

Thinking visually is a vital skill for a game designer. Practice drawing or try making models. To help create animations, film someone walking and then pause the video during playback to see their posture changing.

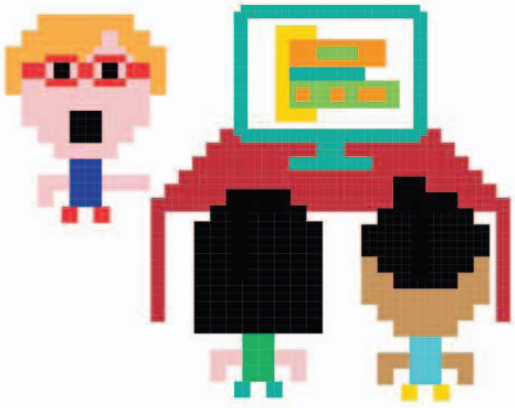


◁ **Keep notes**

Keep a notebook of game ideas, drawings, stories, and anything that you find fun or interesting—you never know what might be useful later. You could even start a blog about gaming to share your ideas with friends and family.

Programming

To make computer games, you need to know how to code. Brushing up on your coding skills will help you make better games.



△ **Code together**

Join or start a coding club at your school or library. Collaborating on projects with other coders is a great way to fire your imagination and supercharge your skills.

▷ **Sharpen your Scratch**

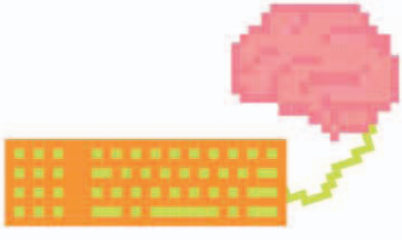
Try the tutorials and explanations on the Scratch website. Learn everything you can about Scratch and you'll be able to code things you never dreamed possible.

△ **Try a game engine**

You don't have to build computer games from scratch—you can use programs called game engines to do a lot of the difficult coding for you. You can find game engines online. Many can be tried for free.

▷ **Learn another language**

Scratch is a great springboard to learn other programming languages, such as Python or JavaScript. There are lots of online coding courses, including some that focus on games. Python has a great add-on called Pygame that helps you create games.



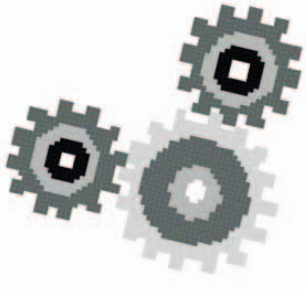
◁ **Do your research**

If you have a technical mind and want to learn more about the latest advances in computer games, read up on 3D graphics, game physics, and artificial intelligence.

EXPERT TIPS

Game engines

A game engine is a program that contains already-made code for building games. It works a bit like Scratch, but it's designed for professional game developers rather than beginners learning to code. Game engines provide easy ways to detect controller inputs and to guide sprites around the screen. Solutions to problems caused by collision detection and game physics are built in. Game engines can also convert games to run on consoles and mobiles, saving you the nuisance of rewriting all the code.

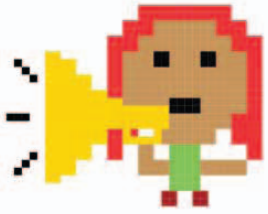


Jobs making games

Some computer games are created by a single programmer, but others are put together by huge teams. The computer games industry employs thousands of people. Most of them specialize in just one part of the process.

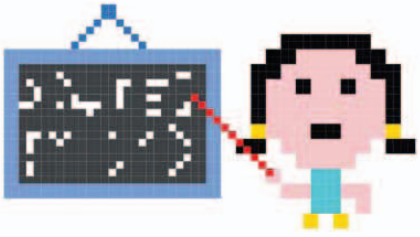
Who makes games?

Game studios are companies that make games and employ specialists to work as a team. On smaller games, each person usually has more than one job. On a big project, there might be dozens of programmers and artists, each working on just a small part of the game.

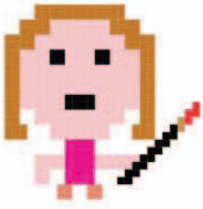


△ **Producer**
The person in charge of a project and all the people working on it is called a producer. It's the job of this producer to make sure the game is the best it can be.

△ **Writer**
The stories and characters in a game are developed by writers. In a game with cutscenes (short, movielike sequences), the writer is responsible for what the characters say.



△ **Game designer**
The game designer creates the rules, goals, and mechanics that make a game interesting and fun for players. Playability is the designer's main focus.



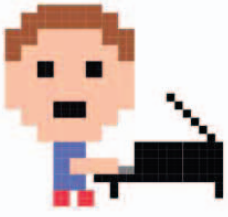
◁ **Artist**
Everything the player sees—the characters, objects, and scenery—are created by artists, often working as a team under a single lead artist.

LINGO

Game types

Indie games Short for "independent games", these are created by people working on their own or in small teams. Many feature creative new ideas not seen in mainstream games.

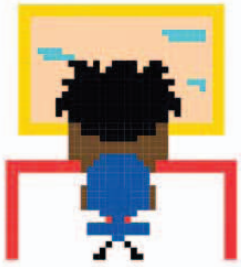
AAA games These are the biggest games and are expected to sell millions of copies. They take many months or even years to make and have huge teams and budgets of many millions of dollars.



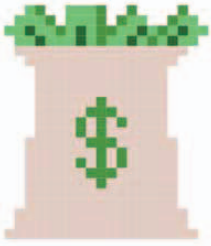
△ **Composer**
A composer is a professional musician who writes new music. Good music is vital because it helps create atmosphere in a game.

△ **Sound designer**
The sound effects in a game help to set the scene. They are created by a sound designer, who also decides how the composer's music will be used in the game.

△ **Programmer**
Programmers take all the ideas and building blocks created by the team and use them to write code that makes the game work.



△ **Tester**
It might sound like a dream job playing games all day, but it's a serious and important part of developing a game. A tester has to play the game over and over to check if it works correctly and is not too easy or hard.



△ **Game publisher**
Some games have a publisher, a company that pays for the game's development and then advertises and distributes the final product.

Game development

Games go through lots of different versions before the final one is released for sale. The early versions take the game from a basic idea to a finished product and usually follow the sequence shown here.

GAME DESIGN

From blocks to riches

In 2009, Swedish programmer Markus "Notch" Persson released the first version of Minecraft, a building game he'd made. By 2014, Minecraft had around 100 million registered users and was sold to Microsoft for $2.5 billion.

1 **Prototype**
The prototype is an experimental version of the game built to see if the basic idea works and is fun to play.

2 **Alpha**
The alpha version has all the main features, but they might not be fully working. They are improved and major bugs are fixed before the next stage.

3 **Beta**
The beta version of the game has everything, but it needs polishing and still has minor bugs, which need to be found and fixed.

4 **Release**
The release is the final version, fully tested and fixed. Some games are available as "early access" releases for fans to test before the game is 100 percent finished.

Have fun!

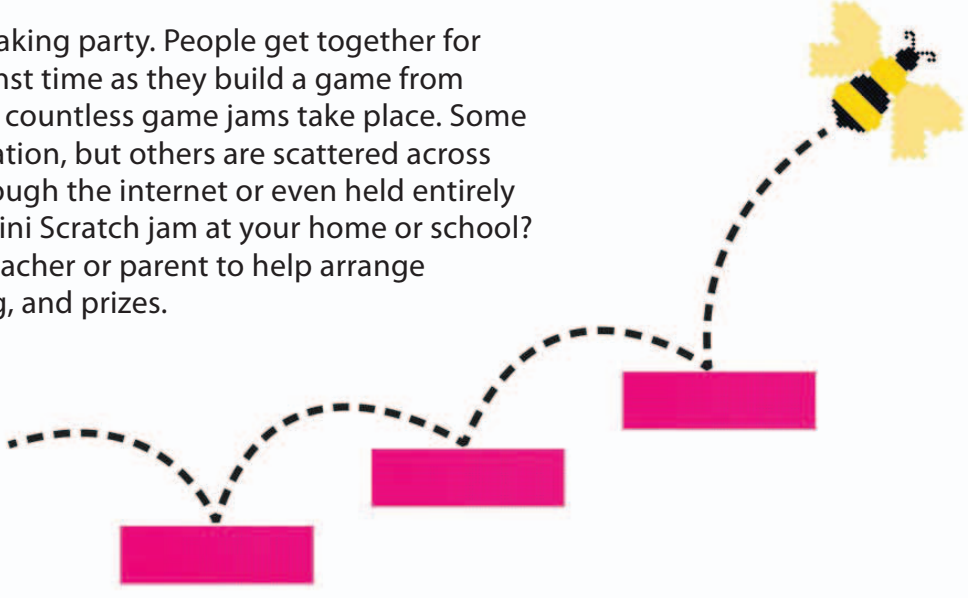
Games can transport you to different worlds and take you through a whirlwind of emotions, but the most important part of gaming and making games is to have fun.

Party time!

Playing games with people is much more fun than playing on your own. Why not grab some snacks and invite your friends around to play your favorite multiplayer game? You could also get them to try out games you've made in Scratch and ask them to suggest improvements. They might even want to create their own versions.

Hold a game jam

A game jam is a game-making party. People get together for a day or two to race against time as they build a game from start to finish. Every year, countless game jams take place. Some take place in a single location, but others are scattered across the world and linked through the internet or even held entirely online. Why not hold a mini Scratch jam at your home or school? Pick a theme and ask a teacher or parent to help arrange computer access, judging, and prizes.



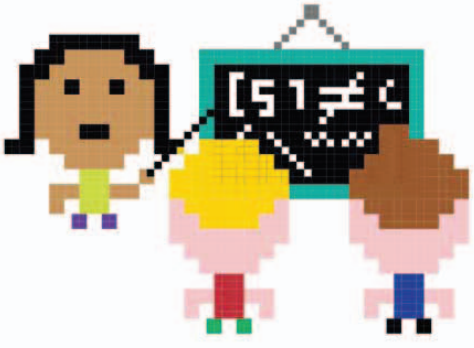
▷ **Choose a theme**
Game jams usually have a theme, such as "jumping games" or "games with bees in them". Prizes are awarded for building the best games.

Challenge yourself

It's good to push yourself sometimes, so why not set yourself a game challenge? It could be anything from making a fully playable game in just 15 minutes to making a game for every letter of the alphabet. You could also keep a diary or blog to describe your experiences, or create a Scratch studio to share your challenge games.

Find or start a game club

If your school or library has a coding club, you can ask them to run some sessions on game design and programming. Start a group within the club for people who have a special interest in making games.



EXPERT TIPS

Game idea generator

For some people, the hardest part of creating games is having the idea for a game in the first place. Here's a trick to help give you inspiration. Roll a dice to choose a number from each column, and then combine the results to generate a random game idea. Feel free to change it—it's just to get your creative brain in gear!

Genre	Setting	Extra feature
1. Maze	1. Forest	1. Patrolling enemies
2. Jumping	2. Space	2. High score
3. Quiz	3. Underwater	3. Collecting objects
4. Vehicle simulator	4. City	4. Life counter
5. Virtual pet	5. Castle	5. Time limit
6. Interactive story	6. Beach	6. Multiplayer

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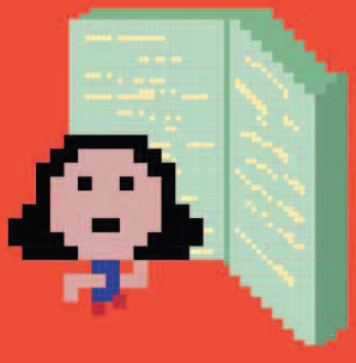
Glossary and Index



Glossary

algorithm
A set of step-by-step instructions that perform a task. Computer programs are based on algorithms.

animation
Changing pictures quickly to create the illusion of movement.

artificial intelligence (AI)
Programming to make characters such as enemies in a game appear to behave in intelligent ways.

assets
All the pictures and sounds used in a game.

backdrop
The picture behind the sprites on the stage in Scratch.

backpack
A storage area in Scratch that allows you to copy things between projects.

block
An instruction in Scratch that can be joined to other blocks to build a script.

Boolean expression
A statement that is either true or false, leading to two possible outcomes. Boolean blocks in Scratch are hexagonal rather than round.

branch
A point in a program where two different options are available, such as the "if then else" block in Scratch.

bug
A coding error that makes a program behave in an unexpected way. Bugs are named after the insects that got into the wiring of early computers, causing errors.

camera
The imaginary camera through which a player views a game.

collision detection
Programming that detects when two objects in a game are touching.

condition
A "true or false" statement used to make a decision in a program. See also *Boolean expression*.

console
A computer that is used just for playing games.

costume
The picture a sprite shows on the stage. Rapidly changing a sprite's costumes can create an animation.

data
Information, such as text, symbols, or numbers.

debug
To look for and correct errors in a program.

directory
A place to store files to keep them organized.

event
Something a computer program can react to, such as a key being pressed or the mouse being clicked.

execute
See *run*.

export
To send something to the computer from Scratch, such as a sprite or a whole project saved as a computer file.

file
A collection of data stored with a name.

flag
A variable that is used to pass information from one sprite or script to another.

function
Code that carries out a specific task, working like a program within a program. Also called a procedure, subprogram, or subroutine.

game engine
A program that helps a programmer make games by providing already-made code for many common game features, such as animation, controls, and game physics.

game jam
A competition in which game makers race against the clock to build the best game.

game loop
A loop that controls everything that happens in a computer game.

game physics
Programming to create forces and collisions between objects in a game.

genre
A type of computer game. Platform games and first-person shooters are common genres.

global variable
A variable that can be changed and used by any sprite in a project.

graphics
Visual elements on a screen that are not text, such as pictures, icons, and symbols.

GUI
The GUI, or graphical user interface, is the name for the buttons and windows that make up the part of the program you can see and interact with.

hardware
The physical parts of a computer that you can see or touch, such as wires, the keyboard, and the screen.

header block
A Scratch block that starts a script, such as the "when green flag clicked" block. Also known as a hat block.

import
To bring something in from outside Scratch, such as a picture or sound clip from the computer's files.

index number
A number given to an item in a list.

input
Data that is entered into a computer. Keyboards, mice, and microphones can be used to input data.

integer
A whole number. An integer does not contain a decimal point, nor is it written as a fraction.

interface
The means by which the user interacts with software or hardware. See *GUI*.

library
A collection of sprites, costumes, or sounds that can be used in Scratch programs.

list
A collection of items stored in a numbered order.

local variable
A variable that can be changed by only one sprite. Each copy or clone of a sprite has its own separate version of the variable.

loop
A part of a program that repeats itself, removing the need to type out the same piece of code multiple times.

mechanics
The actions a player can do in a game, such as jump, collect objects, or become invisible.

memory
A computer chip inside a computer that stores data.

message
A way to send information between sprites.

network
A group of interconnected computers that exchange data. The internet is a giant network.

operating system (OS)
The program that controls everything on a computer, such as Windows, OS X, or Linux.

operator
A Scratch block that uses data to work something out, such as checking whether two values are equal or adding two numbers together.

output
Data that is produced by a computer program and viewed by the user.

pixel art
A drawing made of giant pixels or blocks, mimicking the appearance of graphics in early computer games.

pixels
The colored dots on a screen that make up graphics.

procedure
Code that carries out a specific task, working like a program within a program. Also called a function, subprogram, or subroutine.

program
A set of instructions that a computer follows in order to complete a task.

programming language
A language that is used to give instructions to a computer.

project
Scratch's name for a program and all the assets that go with it.

random
A function in a computer program that allows unpredictable outcomes. Useful when creating games.

recursion
See *recursion*.

run
The command to make a program start.

Scratcher
Someone who uses Scratch.

script
A stack of instruction blocks under a header block that are run in order.

server
A computer that stores files accessible via a network.

software
Programs that run on a computer and control how it works.

sprite
A picture on the stage in Scratch that a script can move and change.

stage
The screenlike area of the Scratch interface in which projects runs.

statement
The smallest complete instruction a programming language can be broken down into.

string
A series of characters. Strings can contain numbers, letters, or symbols such as a colon.

subprogram or subroutine
Code that carries out a specific task, working like a program within a program. Also called a function or procedure.

variable
A place to store data that can change in a program, such as the player's score. A variable has a name and a value.

Index

Page numbers in **bold** refer to main entries.

Acknowledgments

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